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Moody et al.

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(54) **SYSTEM AND METHOD FOR
CORRELATION AND REAL-TIME DISPLAY
OF MAPPED PSTN TRUNK IDENTIFIERS
AND GATEWAY CONTROL PROTOCOL
ENDPOINTS**

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H04J 1/14 (2006.01)

(52) **U.S. Cl.** 370/496; 370/252

(58) **Field of Classification Search** 370/219,
370/496, 252; 379/134, 45

See application file for complete search history.

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Primary Examiner—Chi Pham

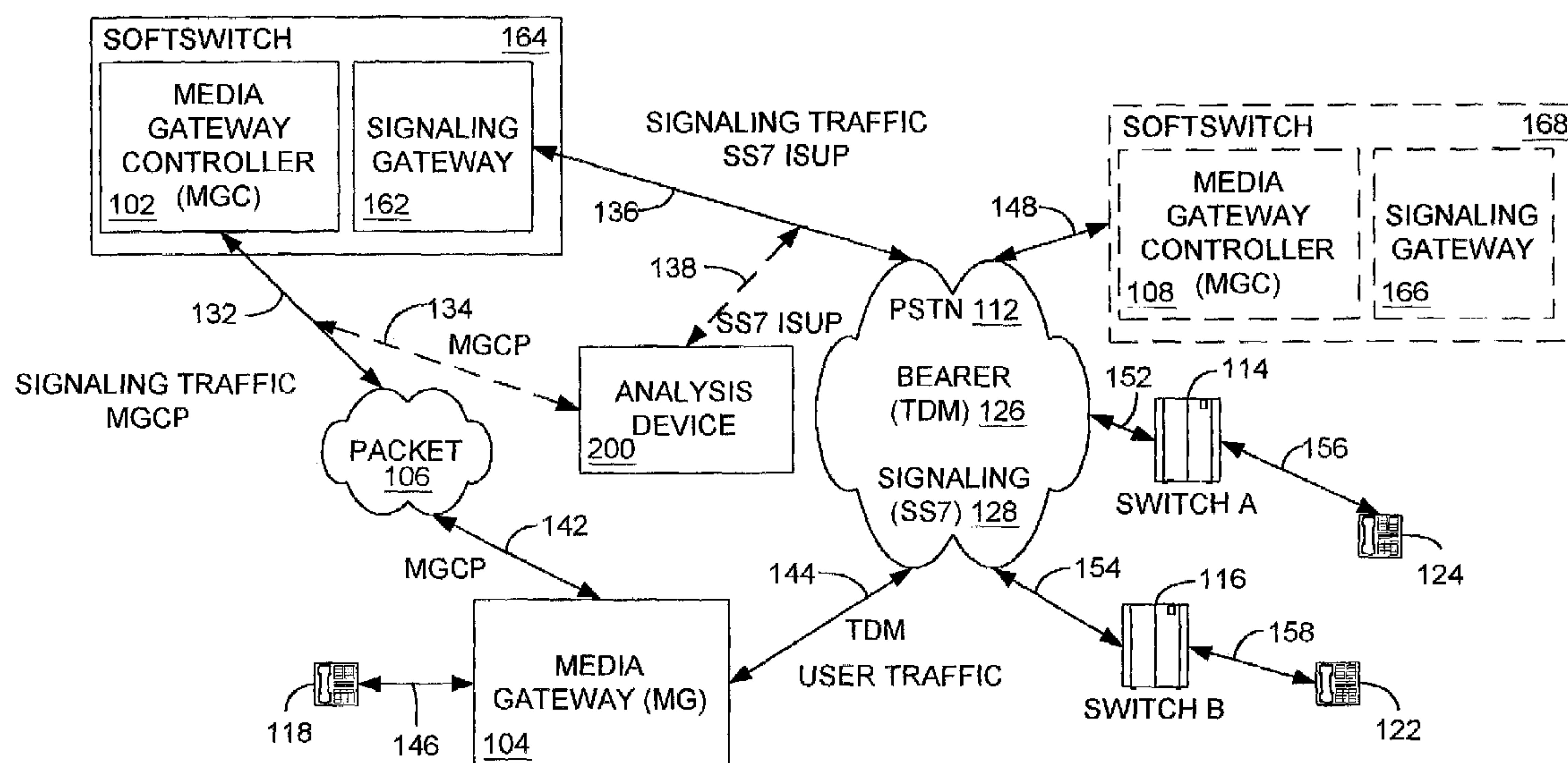
Assistant Examiner—Albert T. Chou

(57) **ABSTRACT**

A system for correlating and displaying dissimilar communication protocols is disclosed. In one embodiment, the system comprises user communication information that spans at least two dissimilar communication networks, a first communication protocol associated with a first communication network, a second communication protocol associated with a second communication network, and a software code segment configured to detect a first call identifier associated with the first communication protocol, the software code segment also configured to detect a second call identifier associated with the second communication protocol, where the first call identifier and the second call identifier are correlated to a particular call. The system displays the correlated call identifiers to a user in a real-time call flow record.

19 Claims, 26 Drawing Sheets

100 →



100 →

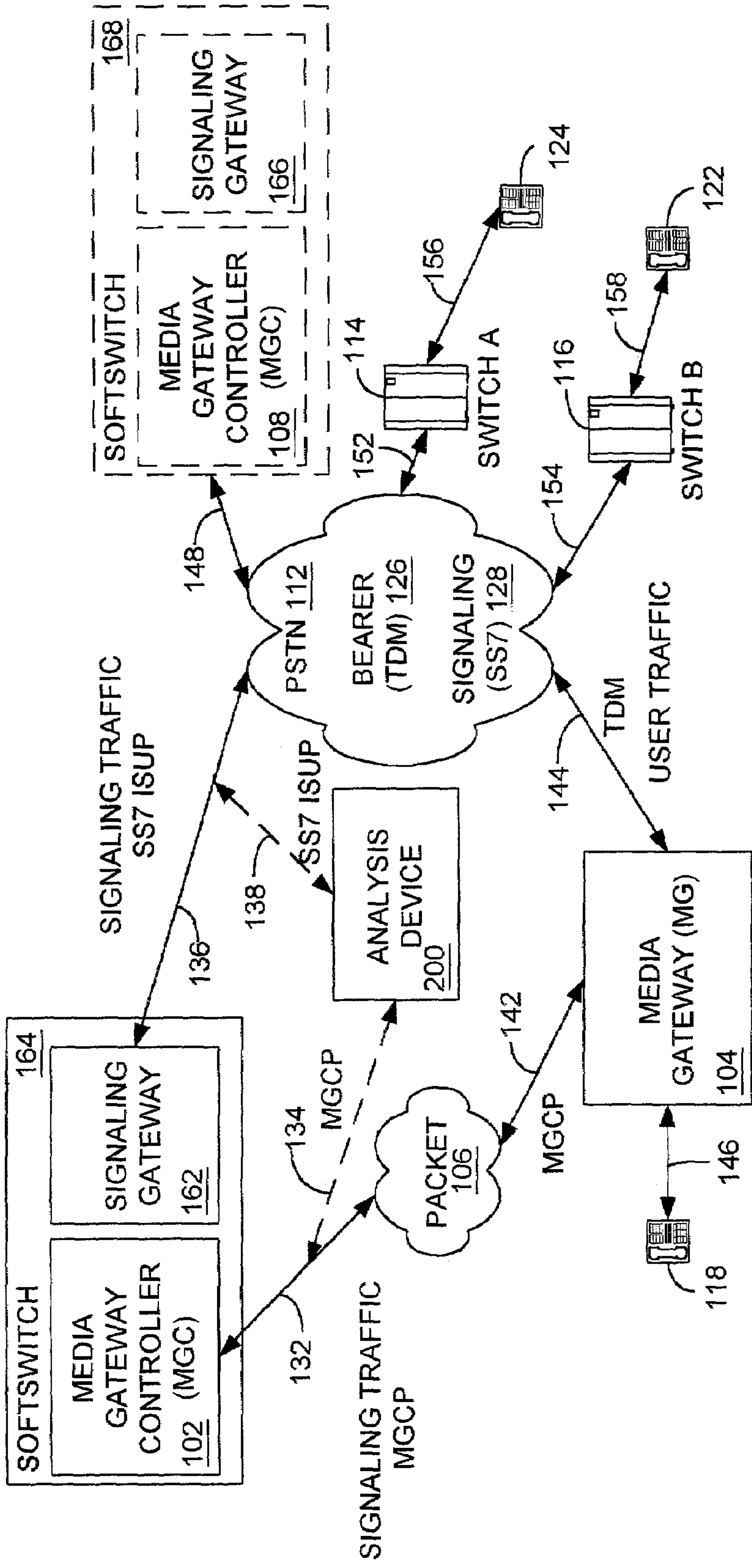


FIG. 1

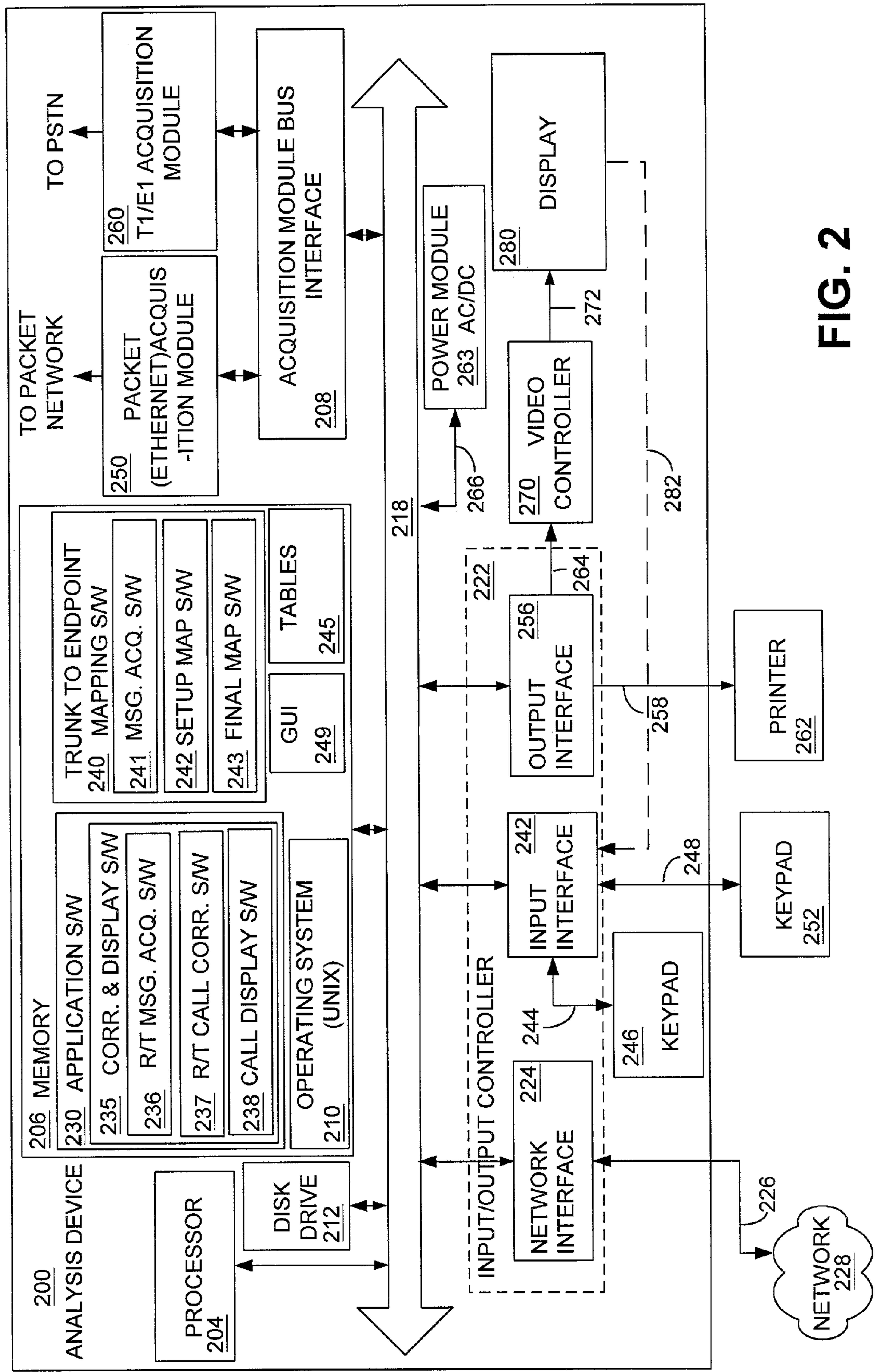


FIG. 2

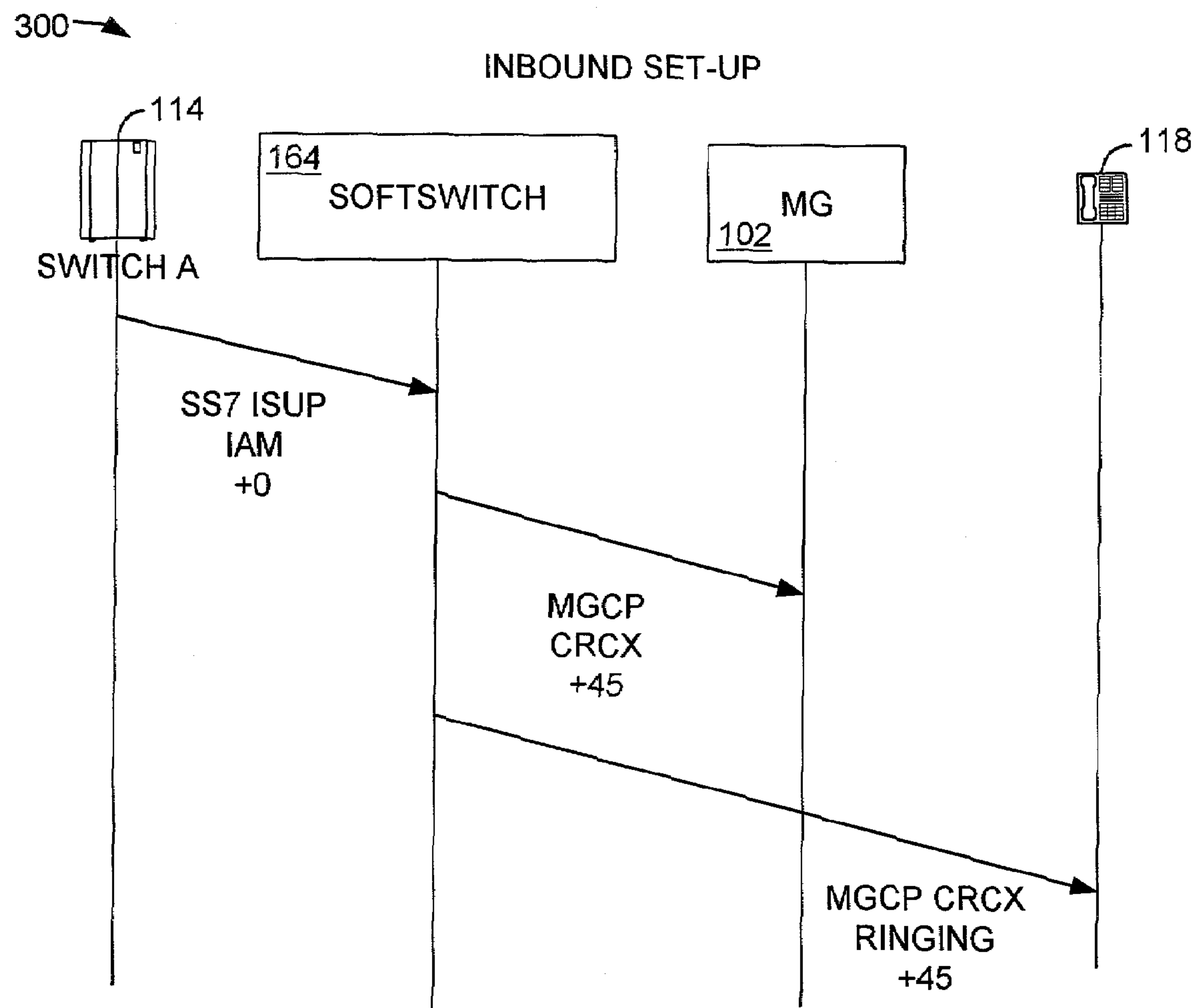


FIG. 3

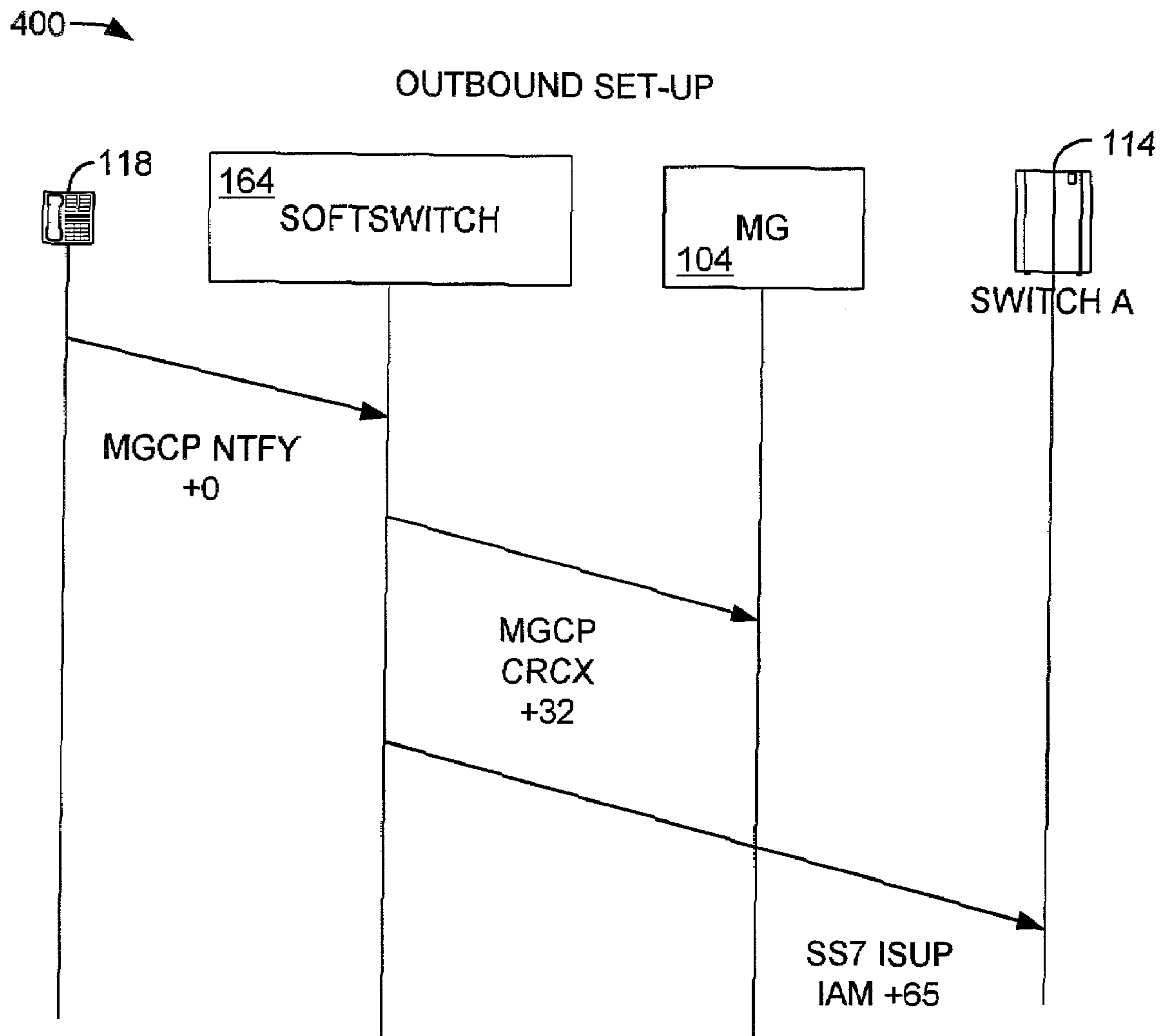


FIG. 4

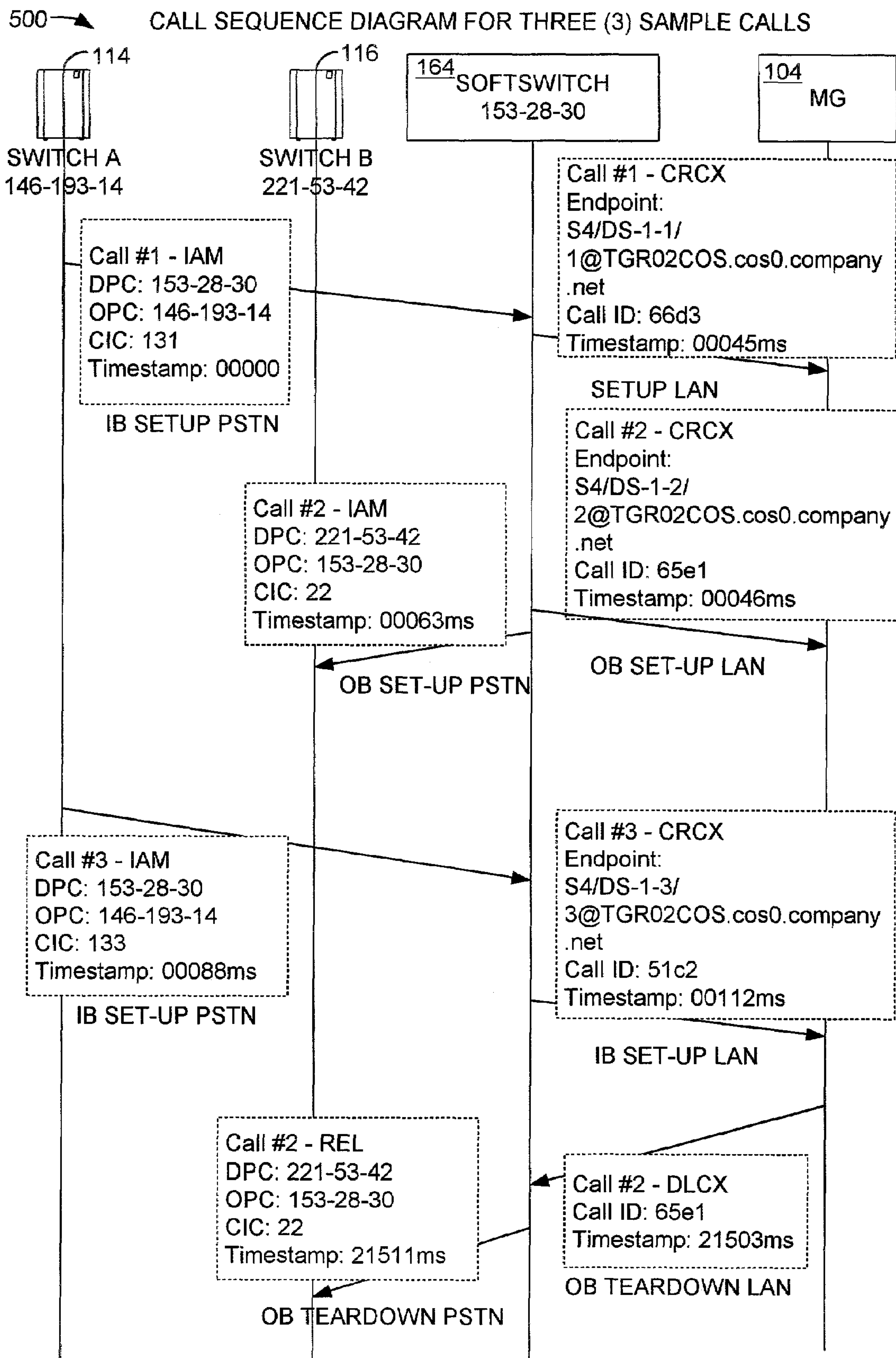


FIG. 5A

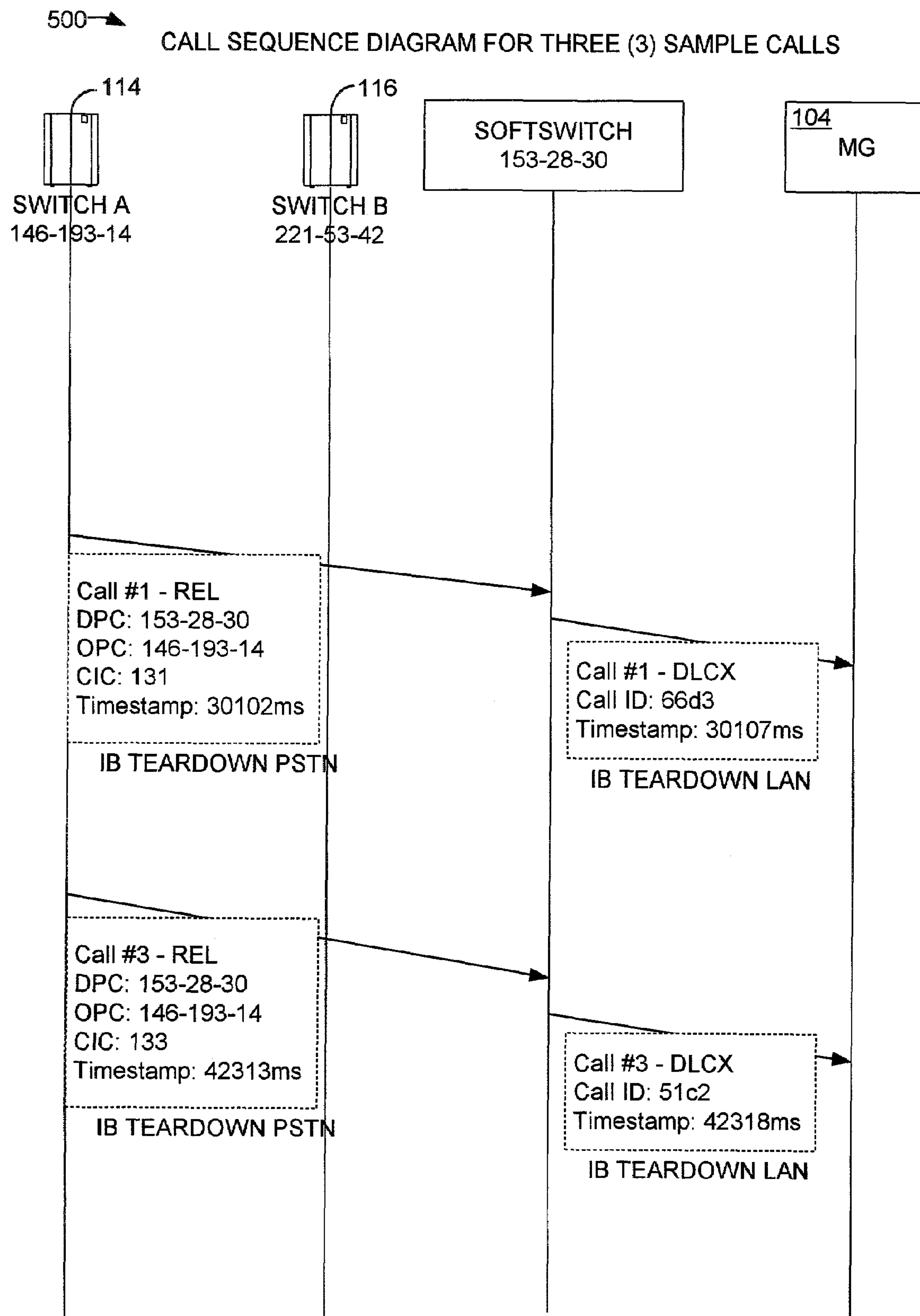


FIG. 5B

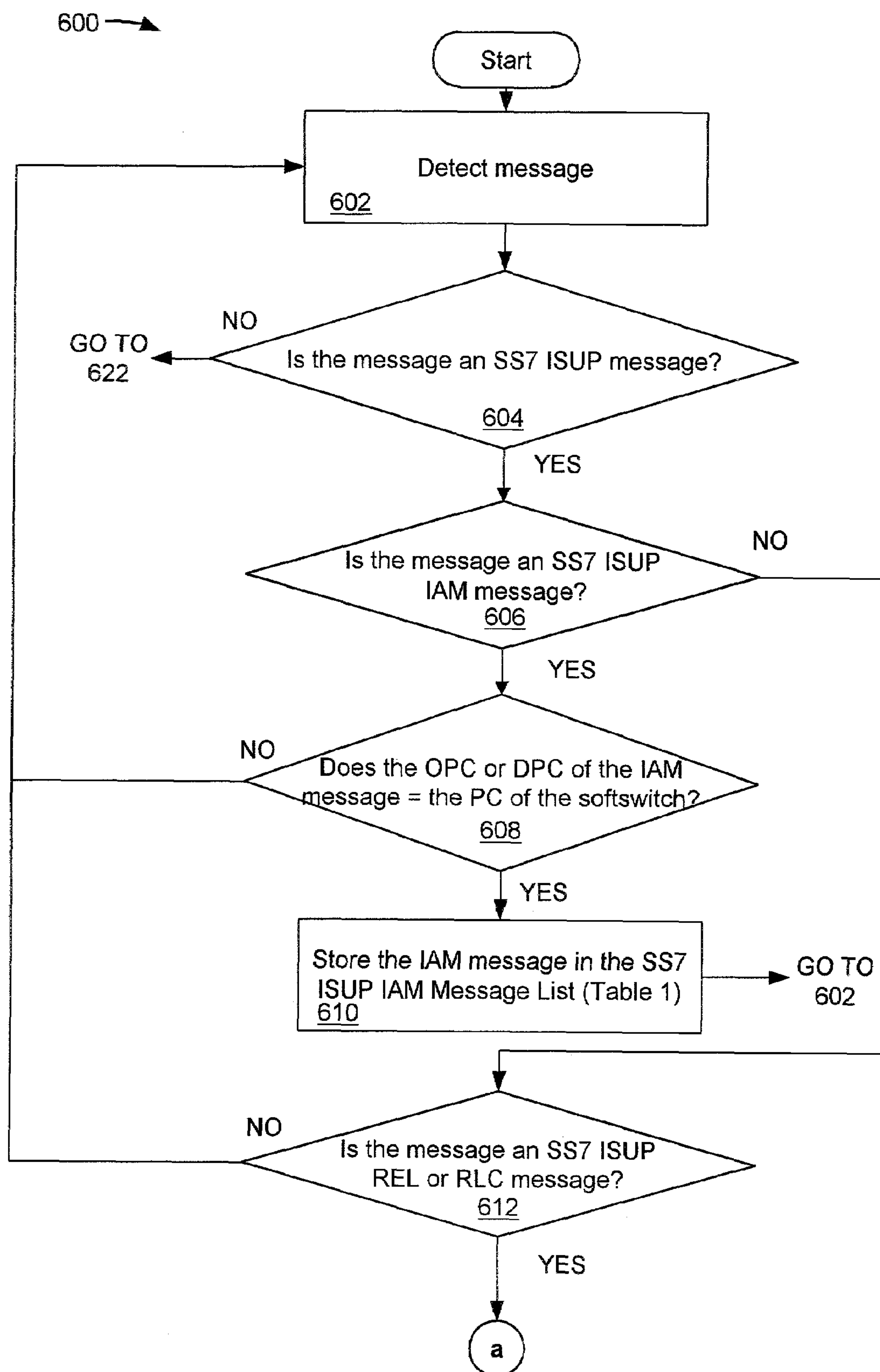
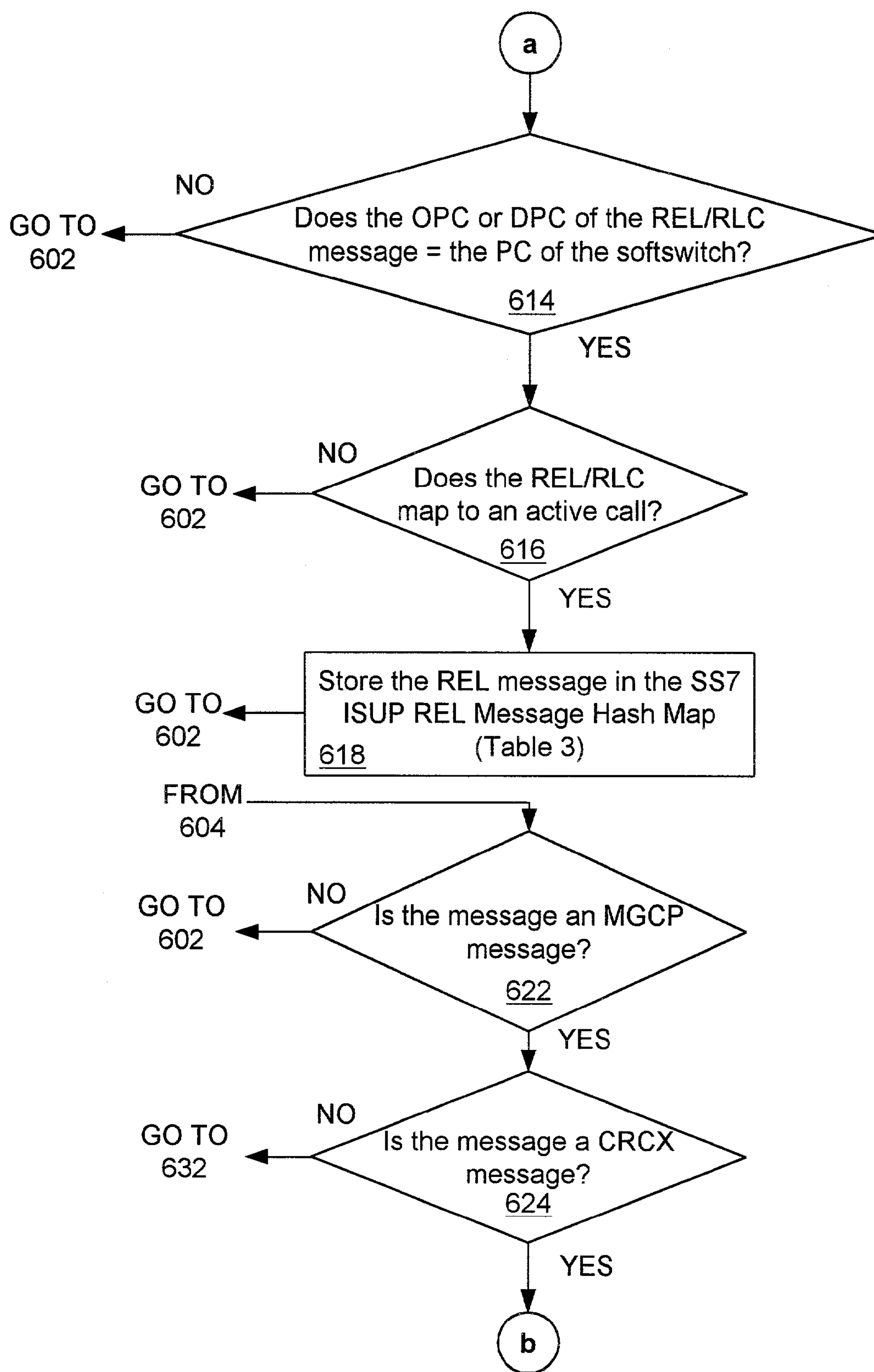


FIG. 6A

**FIG. 6B**

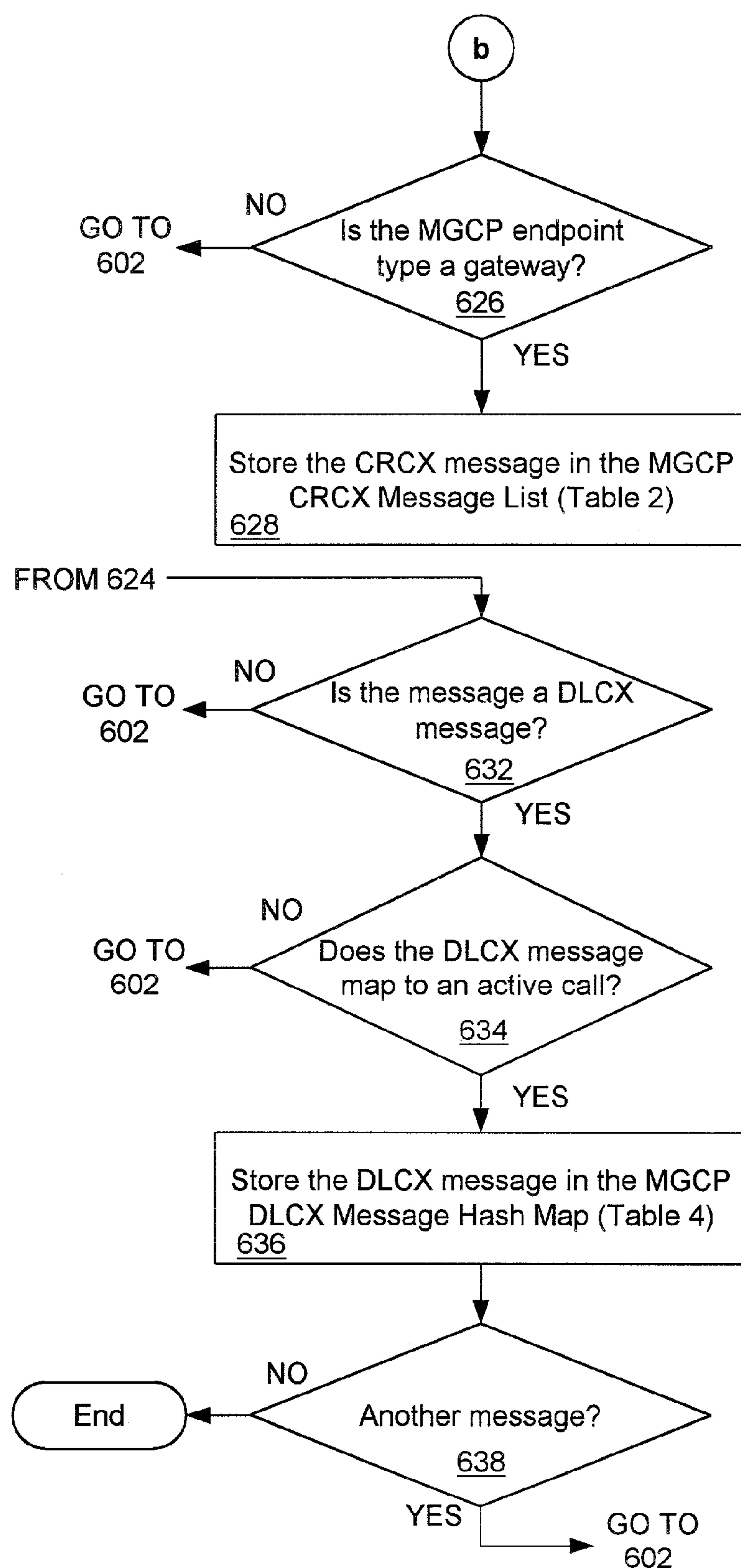


FIG. 6C

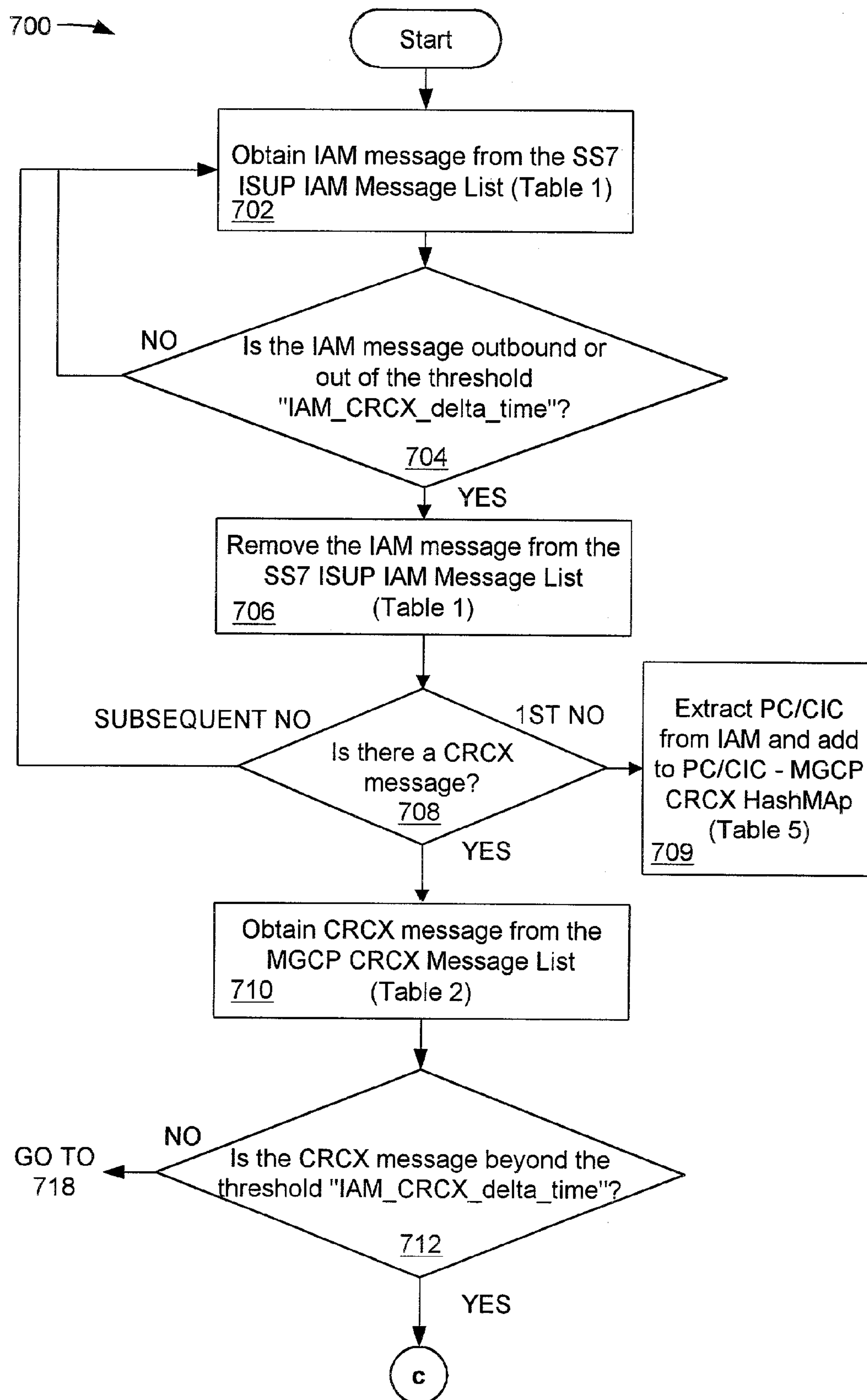


FIG. 7A

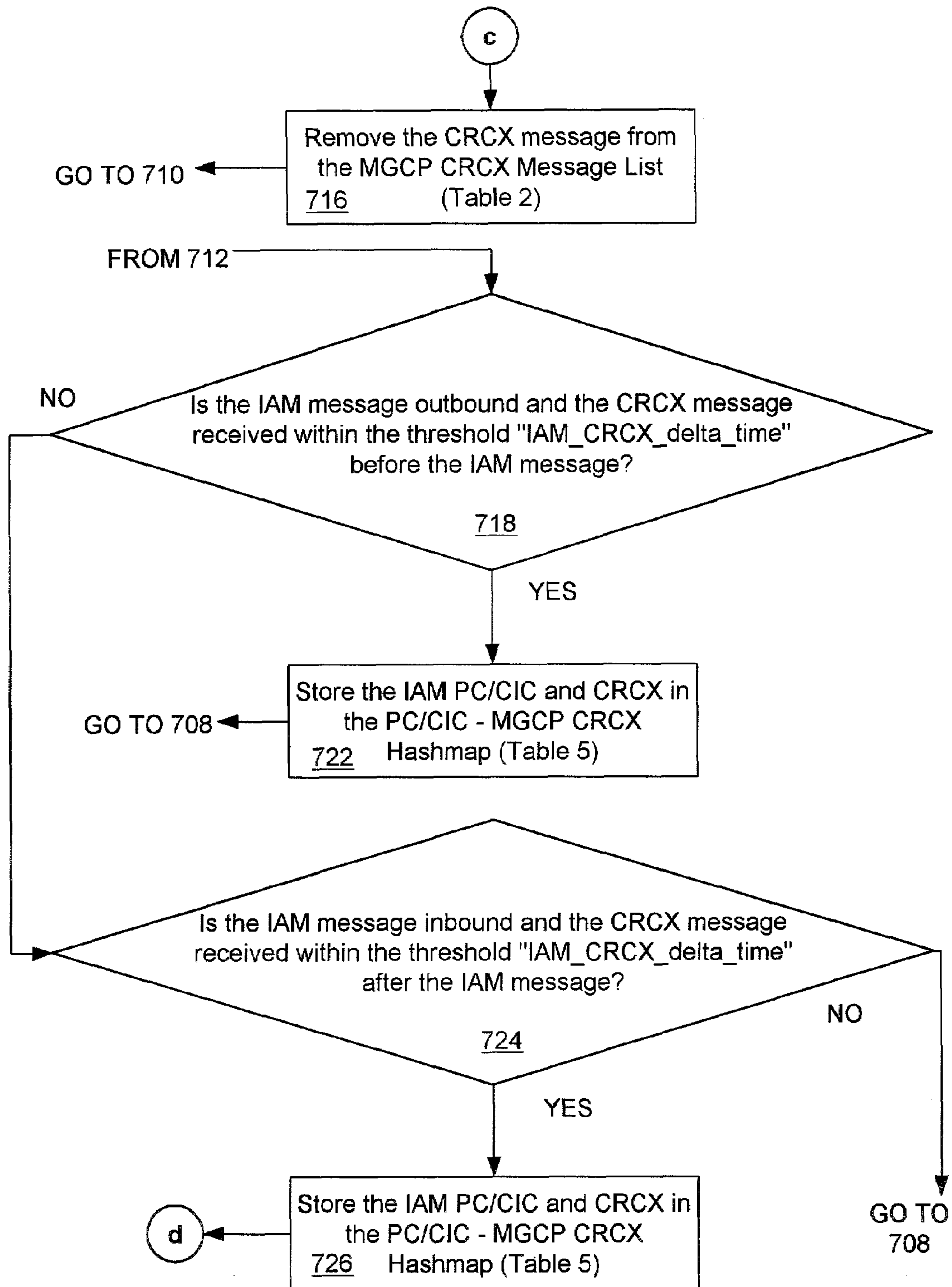
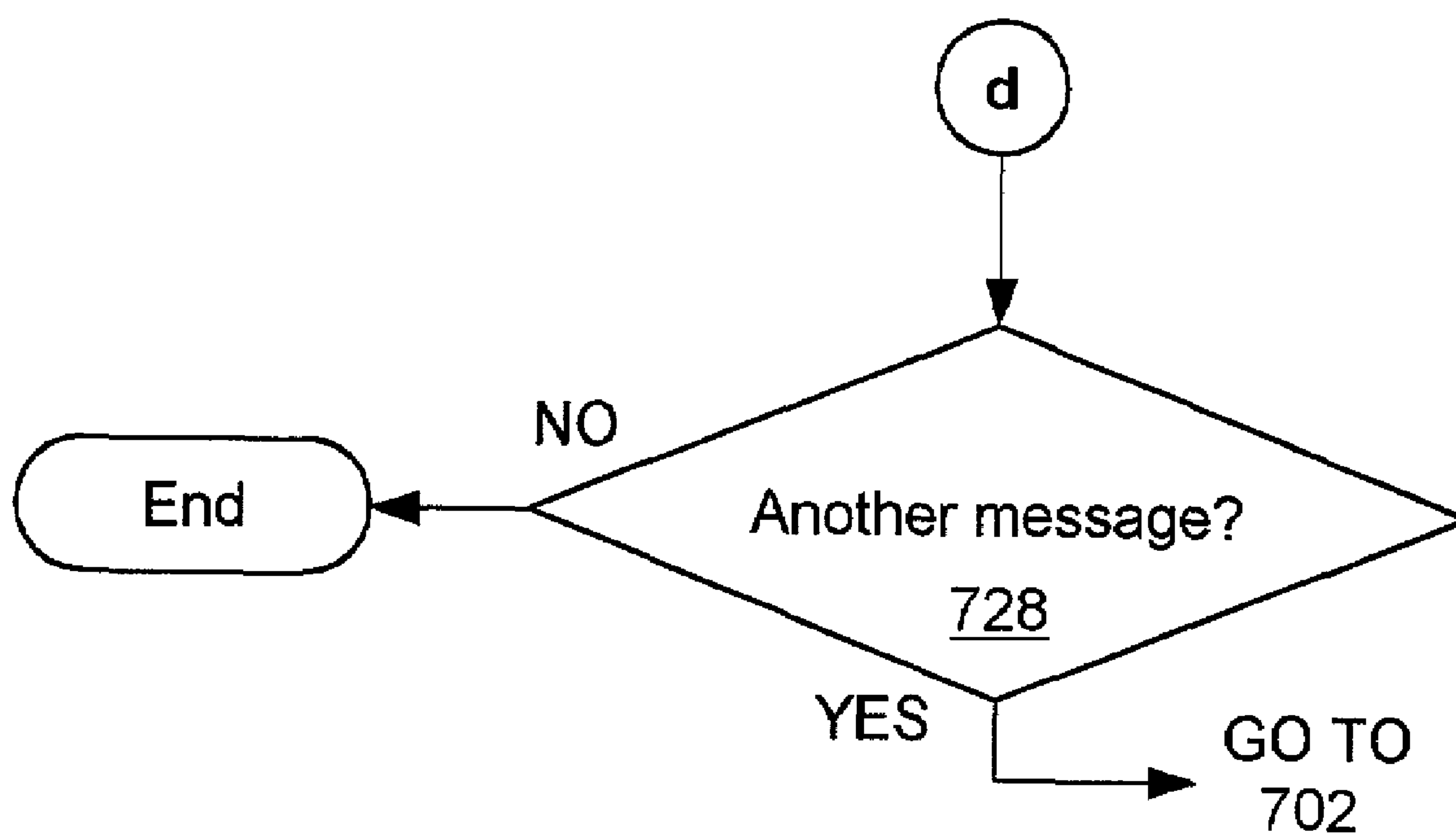


FIG. 7B

**FIG. 7C**

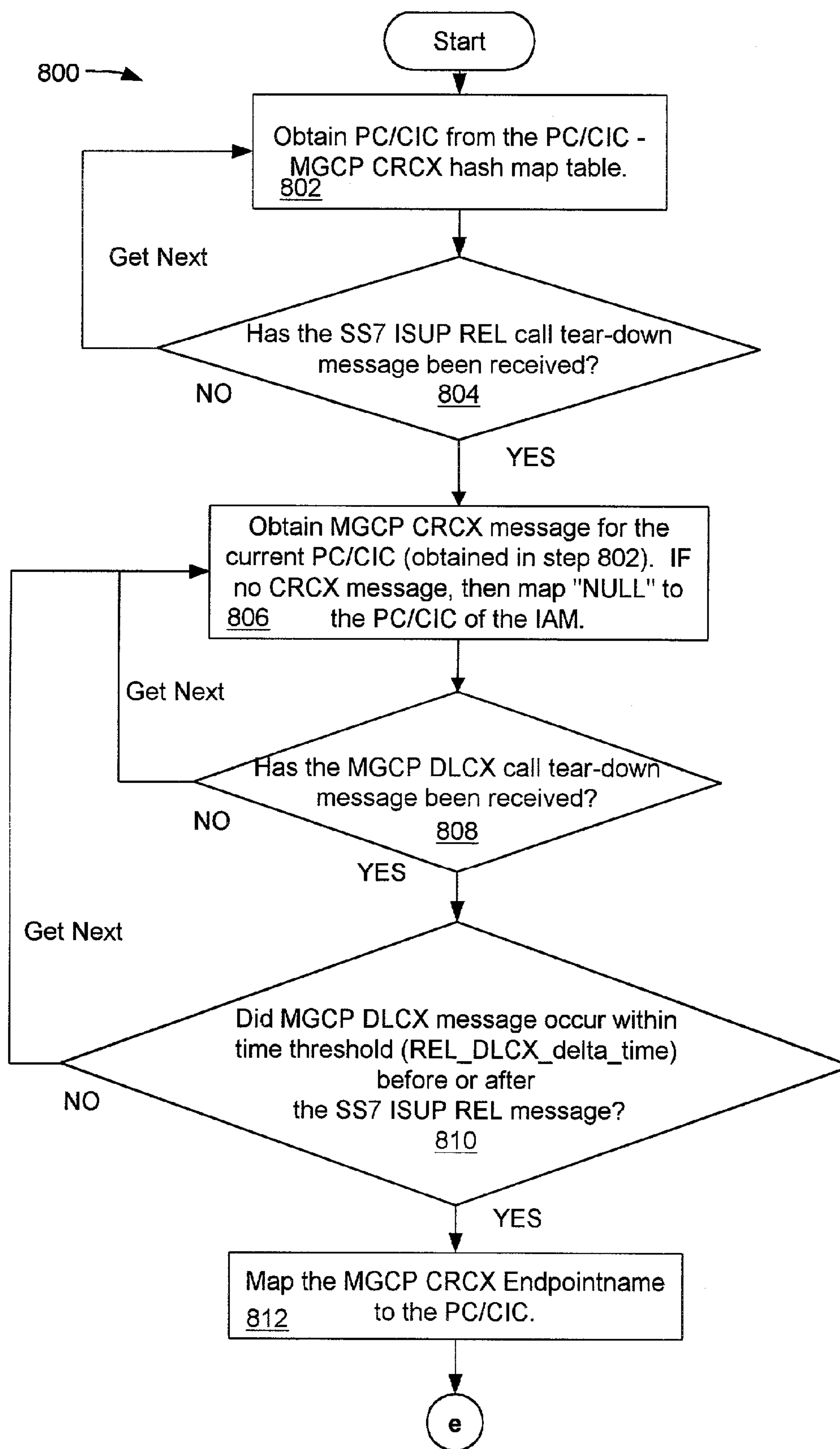
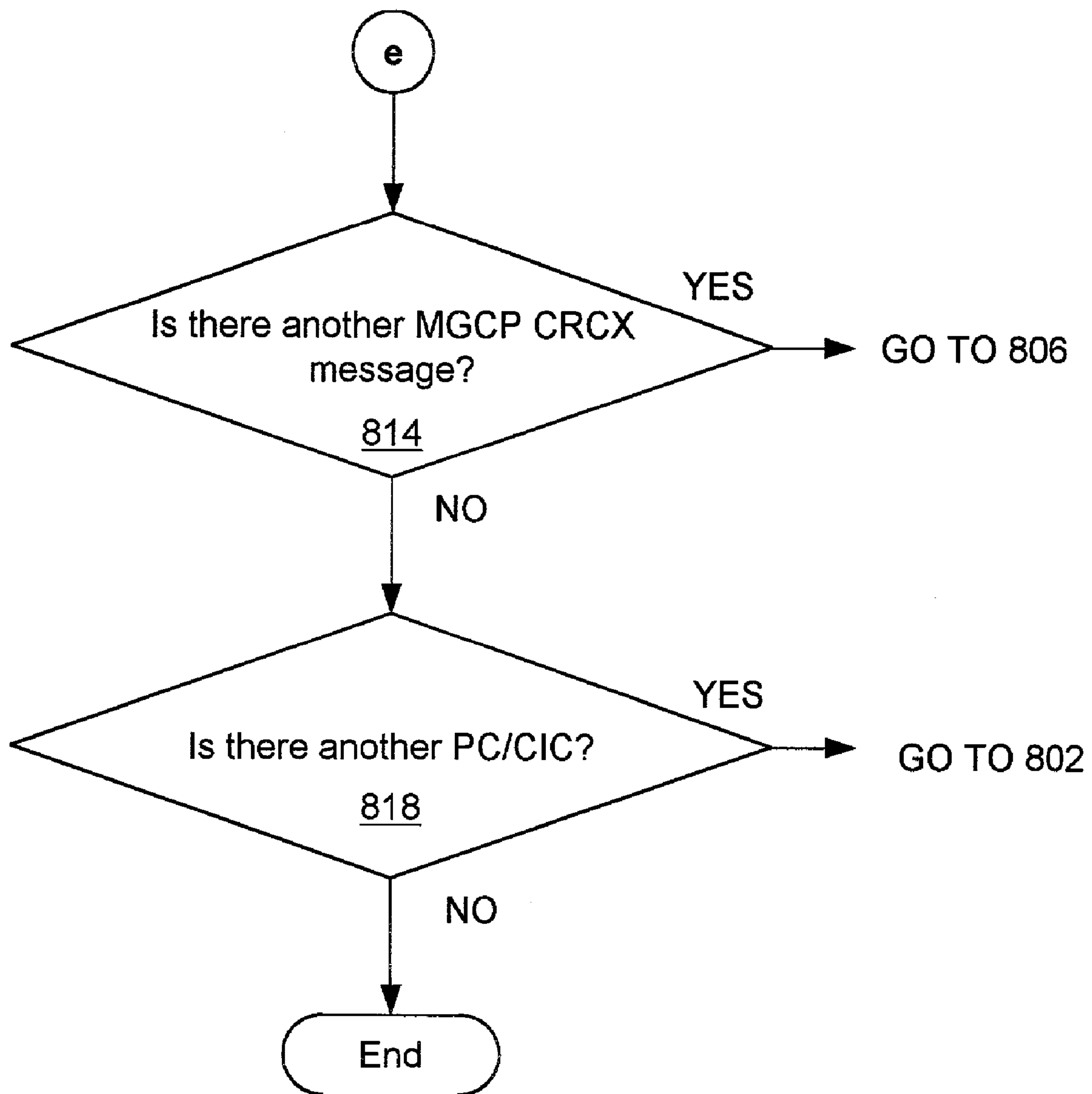


FIG. 8A

**FIG. 8B**

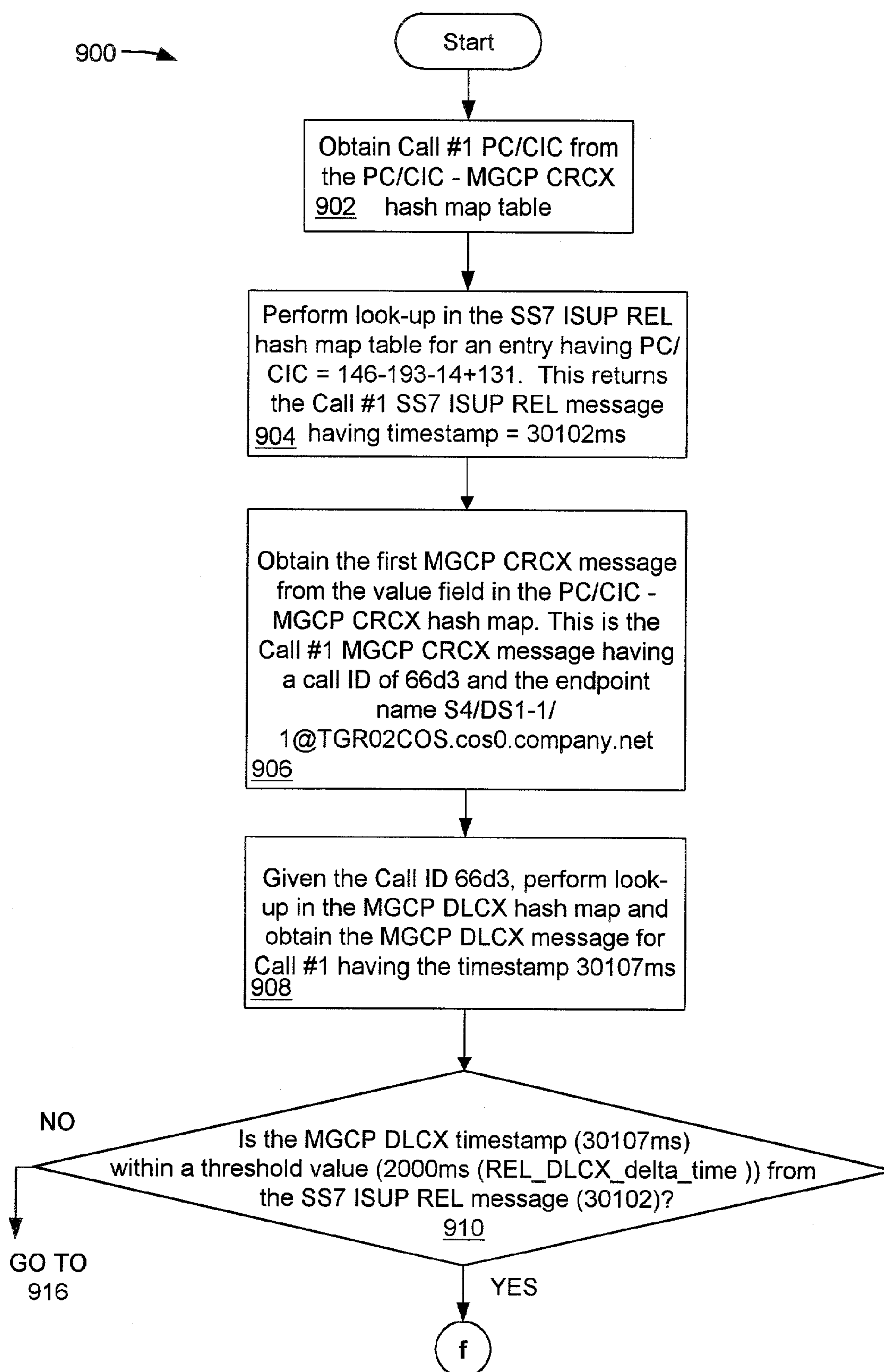


FIG. 9A

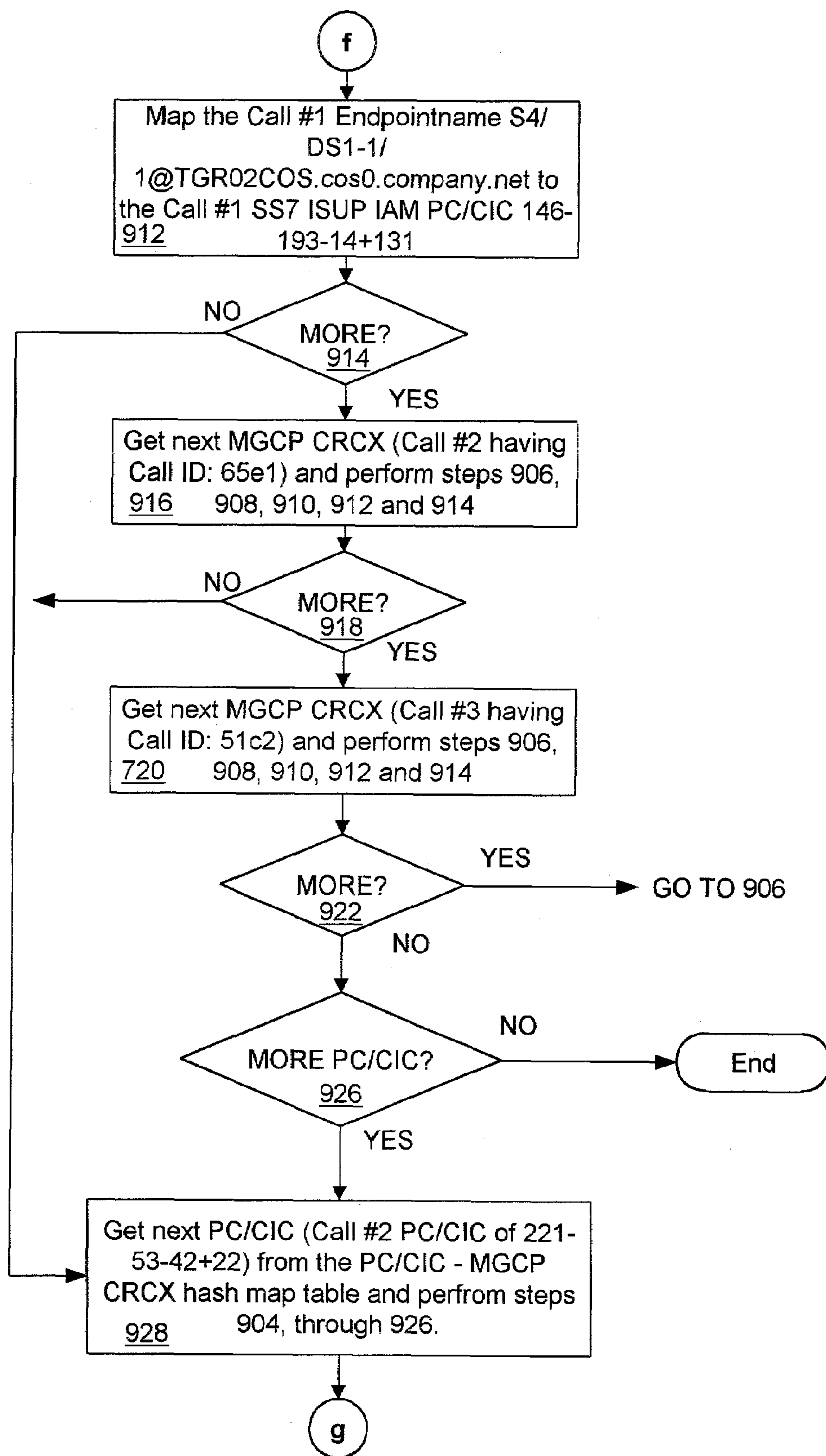
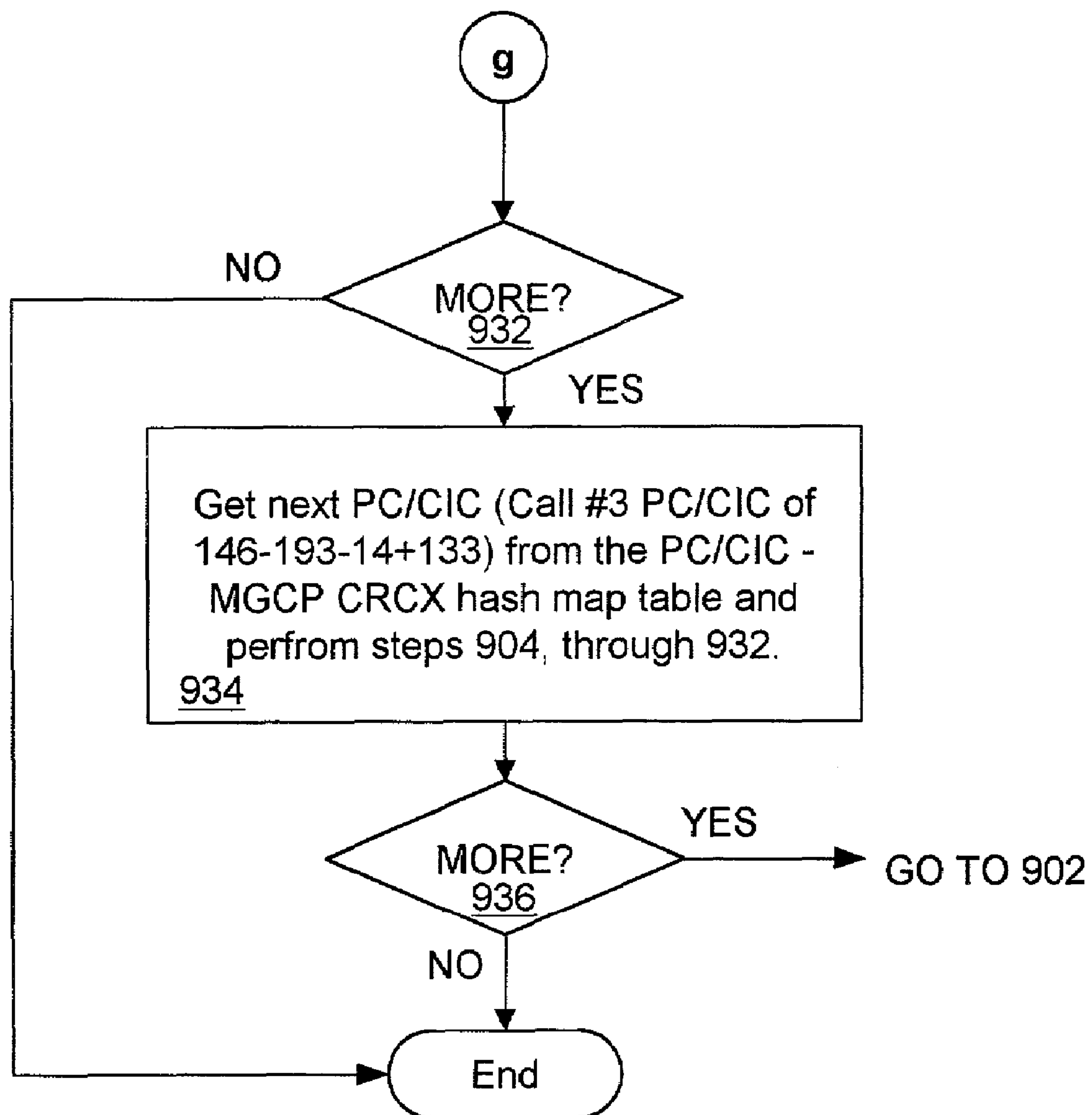


FIG. 9B

**FIG. 9C**

1000 →

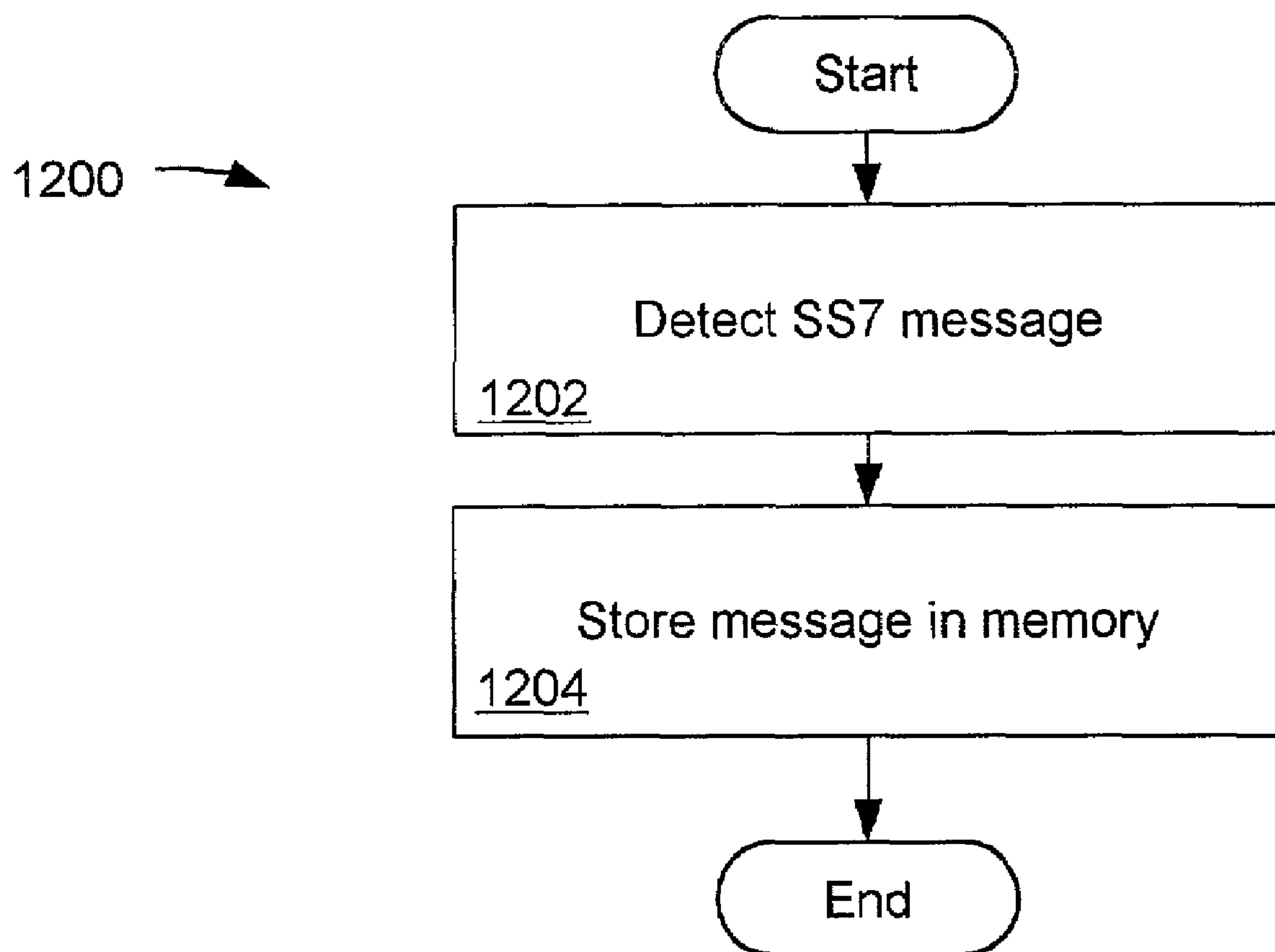
| PC/CIC | Endpoint | Count |
|----------------|--------------------------------------|-------|
| 146-193-14+131 | S4/DS1-1/1@TGR02COS.cos0.company.net | 1 |
| 221-53-42+22 | S4/DS1-2/2@TGR02COS.cos0.company.net | 1 |
| 146-193-14+133 | S4/DS1-3/3@TGR02COS.cos0.company.net | 1 |

FIG. 10

1100 →

| PC/CIC | Endpoint | Count |
|----------------|--|-------|
| 146-193-14+131 | S4/DS1-1/1@TGR02COS.cos0.company.net | 75 |
| 146-193-14+131 | S4/DS1-22/22@TGR02COS.cos0.company.net | 25 |
| 221-53-42+22 | S4/DS1-2/2@TGR02COS.cos0.company.net | 98 |
| 221-53-42+22 | NULL | 2 |
| 146-193-14+133 | S4/DS1-3/3@TGR02COS.cos0.company.net | 77 |
| 146-193-14+133 | NULL | 3 |
| 146-193-14+133 | S4/DS1-2/2@TGR02COS.cos0.company.net | 34 |
| 146-193-14+134 | S4/DS1-4/4@TGR02COS.cos0.company.net | 78 |

FIG. 11

**FIG. 12**

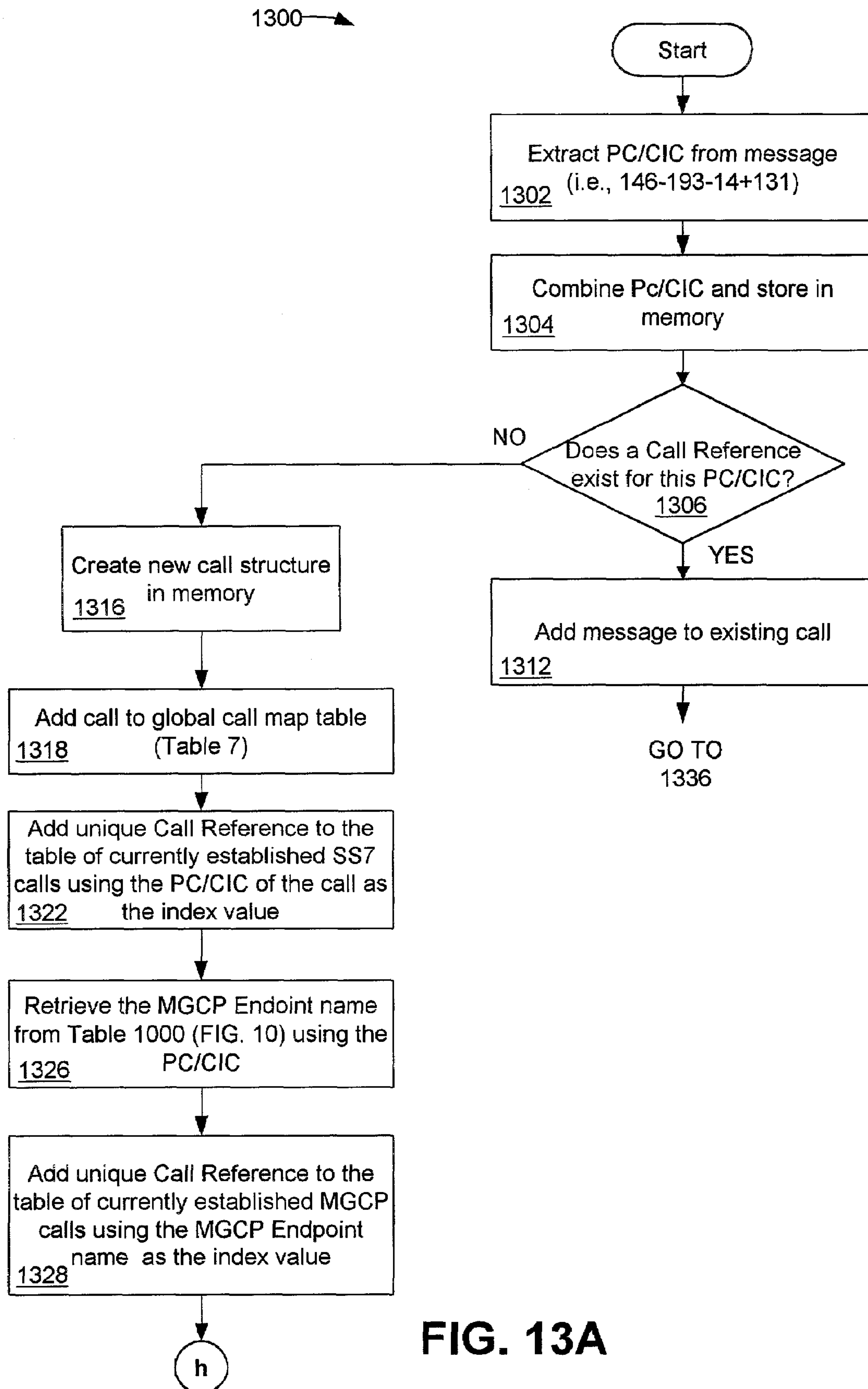
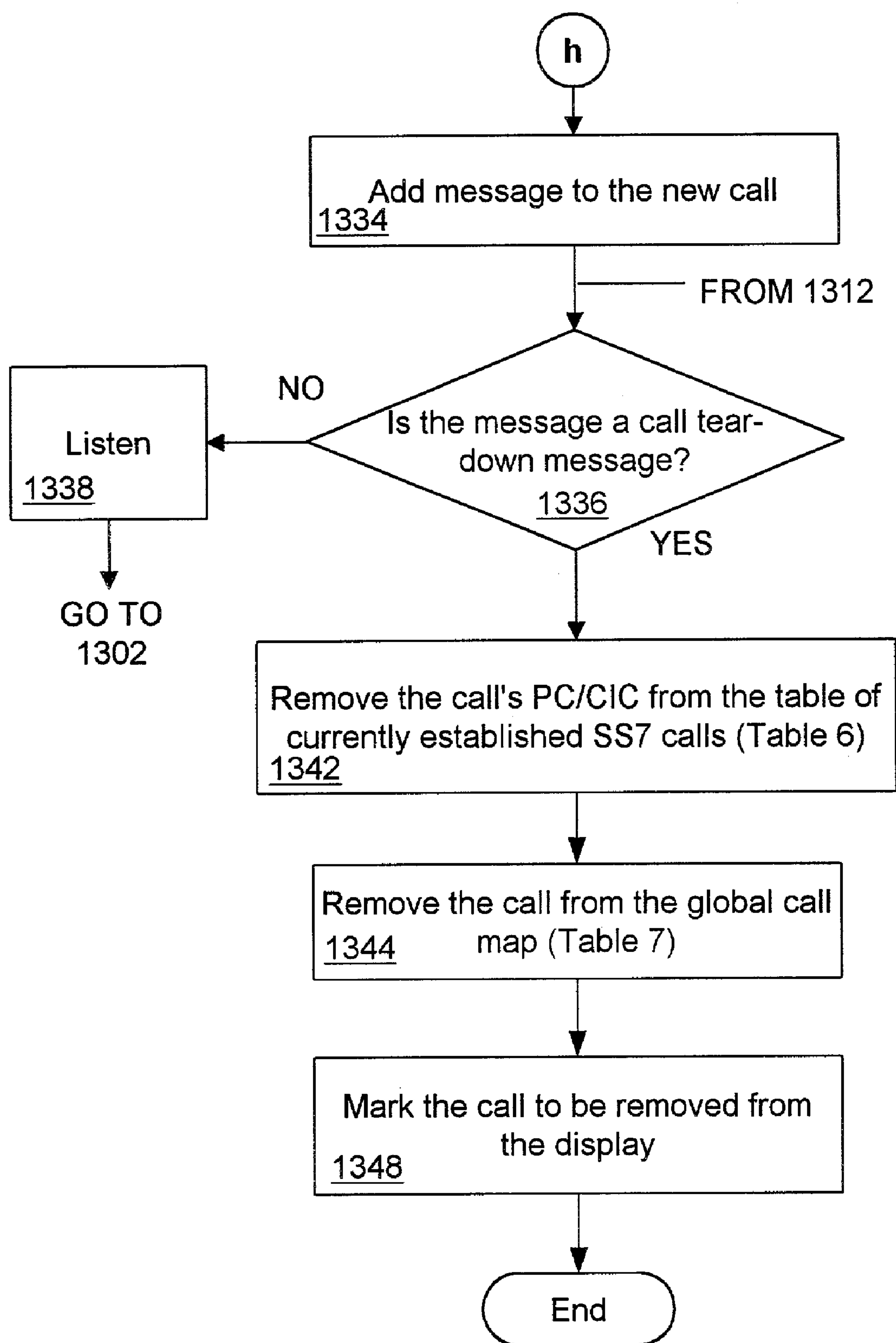
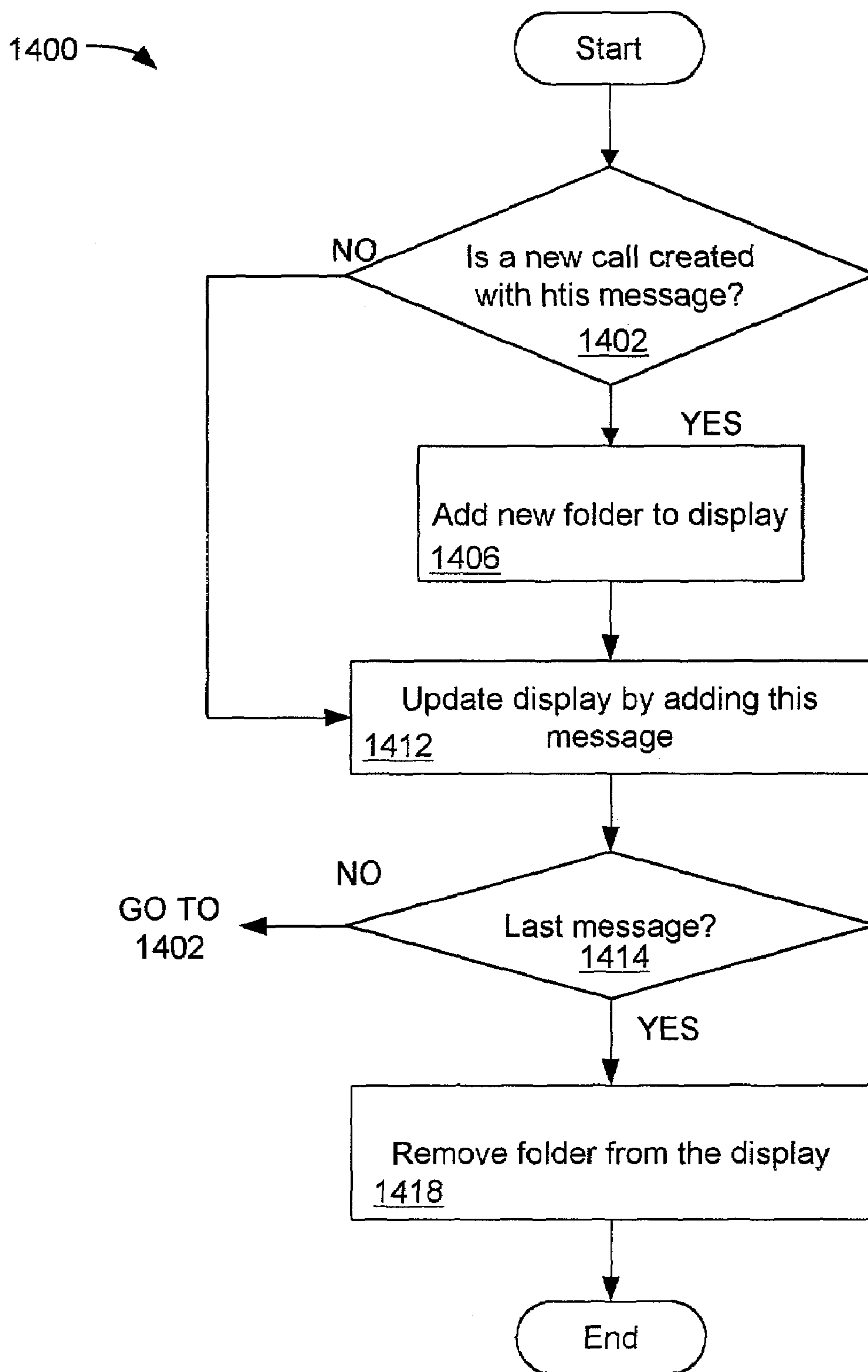
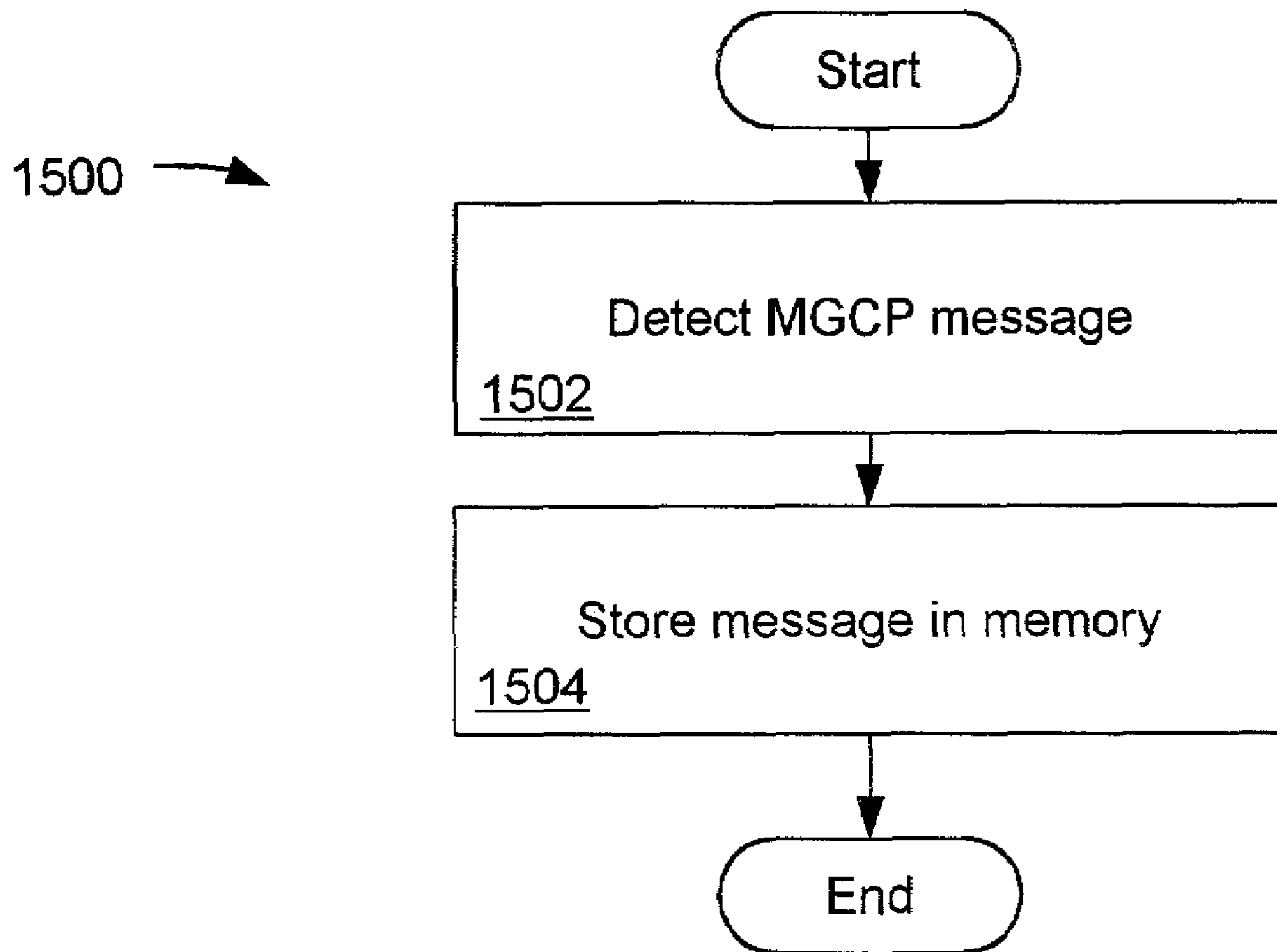


FIG. 13A

**FIG. 13B**

**FIG. 14**

**FIG. 15**

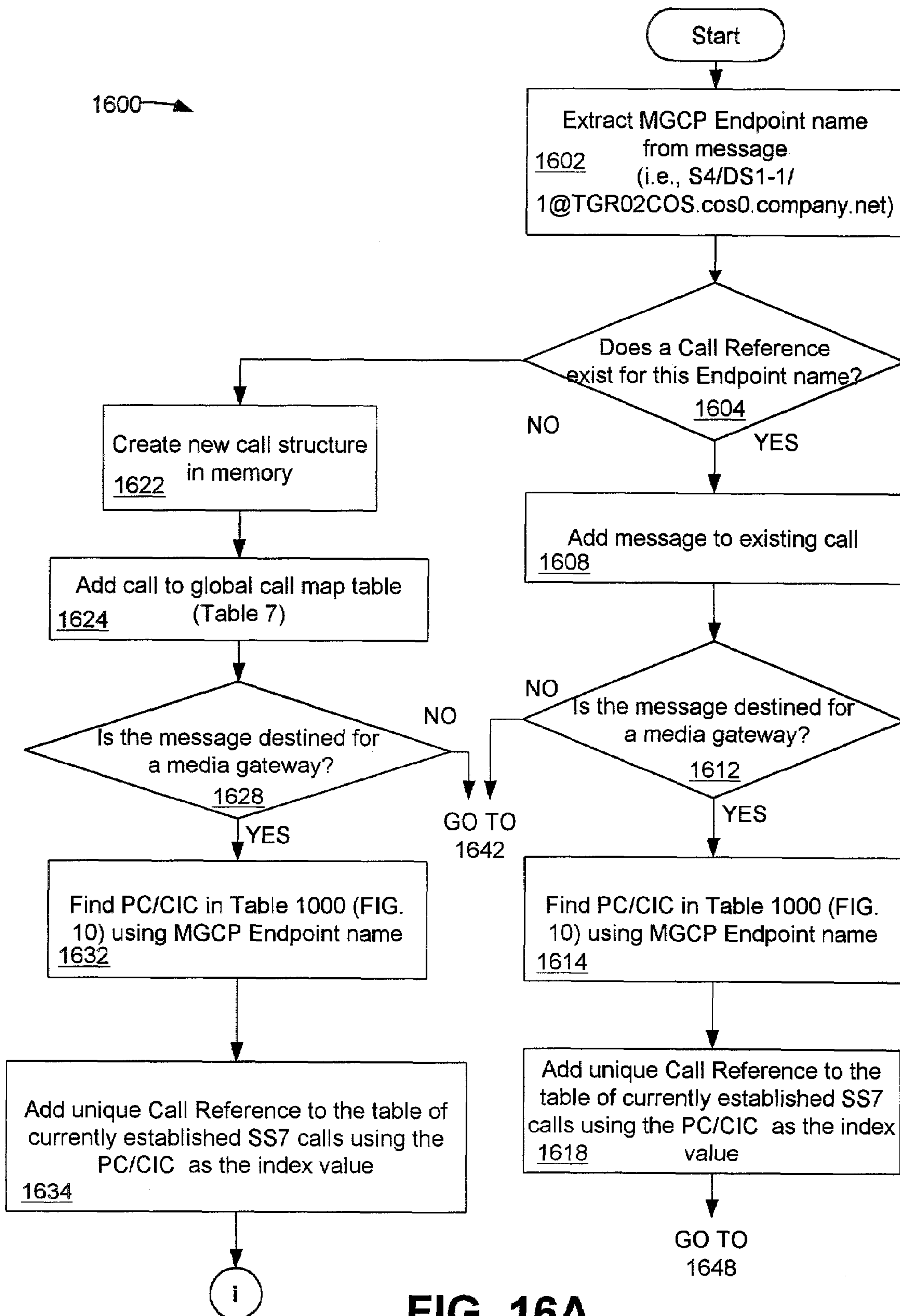
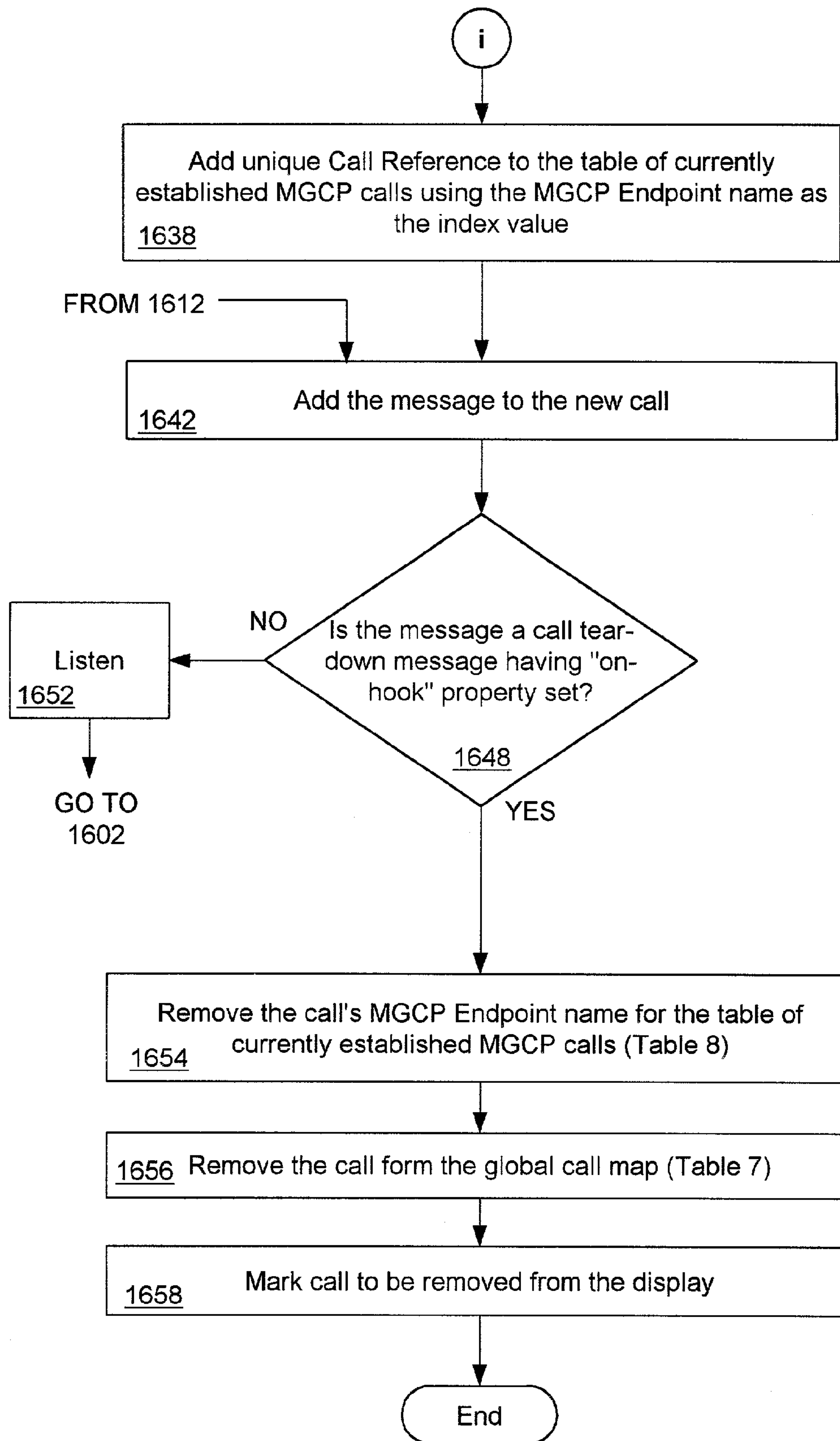


FIG. 16A

**FIG. 16B**

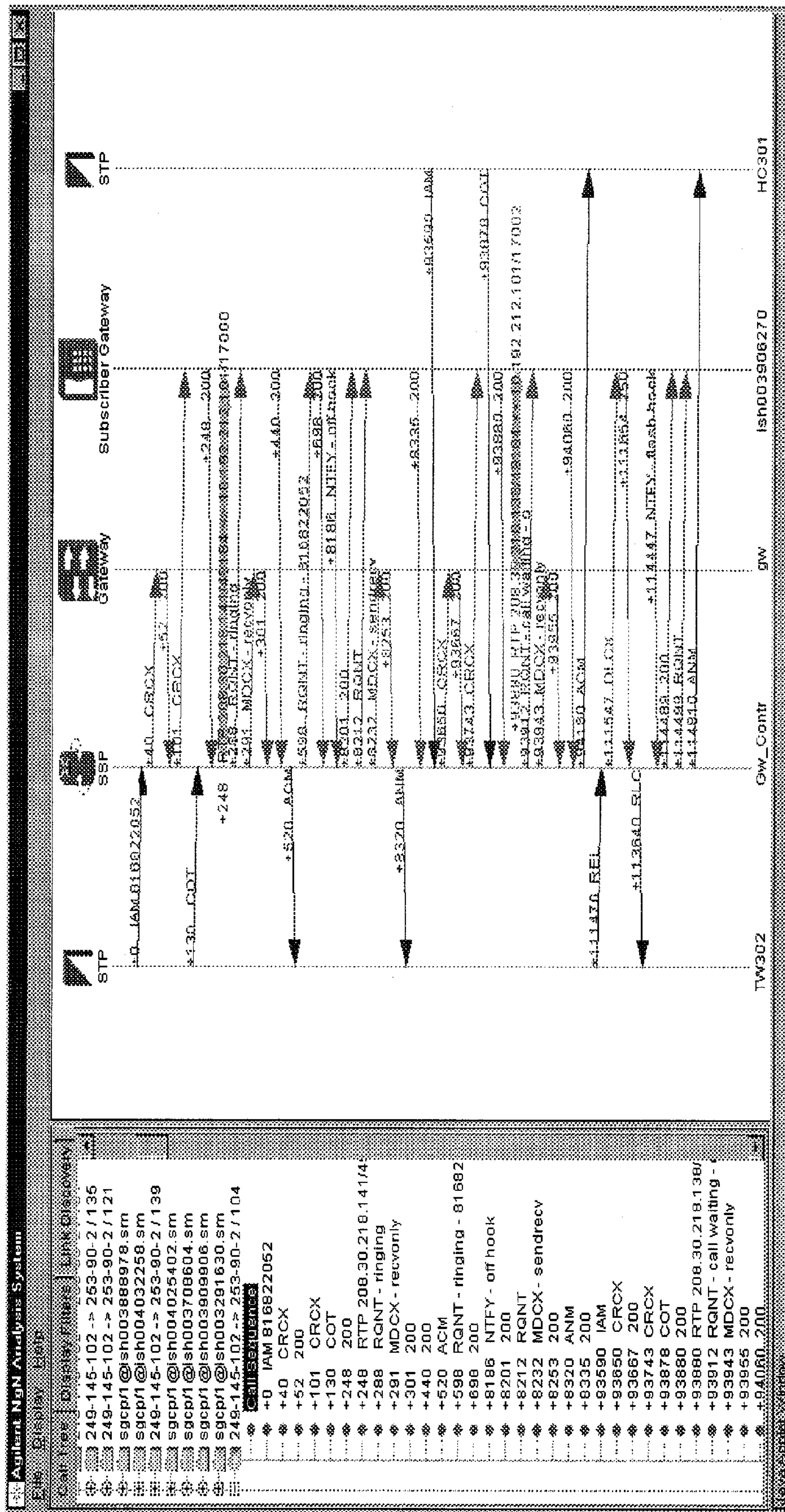


FIG. 17

SYSTEM AND METHOD FOR CORRELATION AND REAL-TIME DISPLAY OF MAPPED PSTN TRUNK IDENTIFIERS AND GATEWAY CONTROL PROTOCOL ENDPOINTS

CROSS-REFERENCE TO RELATED APPLICATION

This application is related to co-pending, commonly assigned U.S. patent application Ser. No. 10/151,374, entitled "SYSTEM AND METHOD FOR MAPPING A PSTN TRUNK TO A PACKET NETWORK ENDPOINT," filed on May 20, 2002, which is hereby incorporated into this document by reference in its entirety.

TECHNICAL FIELD

The invention relates generally to communication systems, and, more particularly, to a system and method for correlation and real-time display of a mapped public switched telephone network (PSTN) trunk identifier to a packet network endpoint.

BACKGROUND OF THE INVENTION

Existing telecommunications networks, such as the public switched telephone network (PSTN) are typically configured so that equipment (such as switches) in the transmission or bearer network, which carries user traffic (voice and data signals), is co-located with equipment (such as signaling points) in the associated signaling network, which carries control signals for coordinating the operation of the bearer network.

However, telecommunications networks are migrating to a distributed architecture in which the equipment that carries user traffic is separated from the equipment that provides signaling functionality. Furthermore, a modern communication network typically comprises dissimilar networks that are coupled together. Such dissimilar networks can include, for example, the PSTN coupled to a packet network. These dissimilar networks generally employ different bearer technologies and/or signaling protocols.

Dissimilar telecommunications networks are typically interconnected via a "gateway" which provides the necessary conversions or adaptations between the bearer traffic and signaling protocol in each of the networks. In such an architecture an adaptation device, such as a media gateway (MG) (sometimes referred to as a "trunk gateway") can be used to couple the dissimilar networks. A control device, such as a media gateway controller (MGC), provides control functionality over the media gateway, but need not be co-located with the media gateway. Generally, the media gateway passes voice and data information. A media gateway controller can communicate with one or more media gateways using a gateway control protocol, such as, for example, simple gateway control protocol (SGCP), media gateway control protocol (MGCP), Internet Protocol Device Control (IPDC), and H.218.

Typically, a media gateway and a media gateway controller are each coupled to both a PSTN and a packet network. The media gateway controller may communicate with other media gateway controllers over the PSTN using extensions of current call control protocols such as Signaling System No.7 ISDN User Part (SS7 ISUP), Session Initiation Protocol (SIP-IETF RFC 2543), ITU Recommendation H.323,

or Bearer Independent Call Control (BICC). New protocols may be defined for this interface in the future.

A media gateway controller communicates with a media gateway using, for example, MGCP. Accordingly, the media gateway does receive signaling messages, but they are from the media gateway controller.

When user traffic, such as a telephone call occurring between a node located in the PSTN and a node located in the packet network, spans the dissimilar communication networks, the user traffic is identified differently by the two communication networks.

Protocol monitoring applications, such as tracing across a signaling network the protocol messages associated with a call, or building a call data record (CDR) to summarize the key parameters relating to user traffic (i.e., a telephone call) requires the ability to map call identifiers across different protocols, which may refer to a single entity in multiple different, inconsistent ways.

However, although the call identifiers that correspond to the different communication protocols may be mapped to each other so that a single call can be identified over dissimilar communication networks, there is no current manner in which to capture and display this information in real time to a user of the system.

Therefore, it would be desirable to have a network analysis device that is capable of mapping two or more different communication protocols referring to the same user traffic in a communication network that comprises at least two dissimilar communication networks, and that displays this information in real time to a user of the network analysis device.

SUMMARY

Embodiments of the invention include a system for correlating and displaying dissimilar communication protocol identifiers, comprising user communication information that spans at least two dissimilar communication networks, a first communication protocol associated with a first communication network, a second communication protocol associated with a second communication network, and a software code segment configured to detect a first call identifier associated with the first communication protocol, the software code segment also configured to detect a second call identifier associated with the second communication protocol, where the first call identifier and the second call identifier are correlated to a particular call. Embodiments of the invention also include displaying the correlated call identifiers to a user in a real-time call flow record.

Other systems, methods, computer readable media, and features of the invention will be or become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, computer readable media, and features, be included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, as defined in the claims, can be better understood with reference to the following drawings. The components within the drawings are not necessarily to scale relative to each other, emphasis instead being placed upon clearly illustrating the principles of the present invention.

FIG. 1 is a schematic view illustrating an exemplar communication environment in which the network analysis device of the invention resides.

FIG. 2 is a block diagram illustrating an exemplar network analysis device constructed in accordance with an embodiment of the invention.

FIGS. 3 and 4 are call flow diagrams illustrating the signaling messages used to setup an inbound call and an outbound call, respectively.

FIGS. 5A and 5B collectively illustrate a call sequence diagram of three calls that will be used to illustrate the operation of certain embodiment of the invention.

FIGS. 6A through 6C comprise a flowchart collectively illustrating the operation of the message acquisition software of FIG. 2.

FIGS. 7A through 7C comprise a flowchart collectively illustrating the operation of the setup message software of FIG. 2.

FIGS. 8A and 8B comprise a flowchart collectively illustrating the operation of the final mapping software 243 of FIG. 2.

FIGS. 9A, 9B and 9C comprise a flowchart collectively illustrating the operation of certain embodiments of the invention with regard to the three calls illustrated in FIGS. 5A and 5B.

FIG. 10 is a table illustrating the operation of the embodiment of the invention described in FIGS. 9A through 9C.

FIG. 11 is a table illustrating a sample mapping of the invention.

FIG. 12 is a flowchart describing the operation of the real-time message acquisition software of FIG. 2.

FIGS. 13A and 13B comprise a flowchart collectively illustrating the operation of the real-time call correlation software 237 of FIG. 2.

FIG. 14 is a flowchart describing the operation of the real-time call display software of FIG. 2.

FIG. 15 is a flowchart describing the operation of the real-time message acquisition software of FIG. 2 as it pertains to an MGCP message.

FIGS. 16A and 16B comprise a flowchart collectively illustrating the operation of the real-time call correlation software as it pertains to an MGCP message.

FIG. 17 is a graphical display illustrating a real-time call flow record (CFR) presented to a user of the analysis device of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The network analysis system in accordance with embodiments of the invention can be implemented in software (e.g., firmware), hardware, or a combination thereof. In one embodiment, the network analysis system for correlating and displaying dissimilar communication network call identifiers is implemented using a dedicated test platform (such as a SUN workstation available from SUN Microsystems) having a dedicated processor, preferably executing the UNIX operating system. However, regardless of the manner of implementation, the software portion of the invention can be executed by a special or general-purpose computer, such as a personal computer (PC; IBM-compatible, Apple-compatible, or otherwise), workstation, minicomputer, or mainframe computer. Furthermore, the invention may be implemented in other processing or computing devices, such as, for example but not limited to, a palmtop computer, a personal data assistant (PDA), or any other piece of network analysis equipment, etc.

FIG. 1 is a schematic view illustrating an exemplar communication environment 100 in which embodiments of the invention reside. The communication environment 100

generally includes two dissimilar communication networks, a packet network 106 and a public switched telephone network (PSTN) 112. The PSTN 112 generally includes a bearer portion 126, over which user traffic, such as a telephone call using time division multiplexed (TDM) is communicated, and a signaling portion 128, over which signaling traffic, such as SS7 traffic, is carried. As will be described in detail below, embodiments of the invention apply generally to the signaling portion 128 of the PSTN 112. The packet network 106 can be, for example, an asynchronous transfer mode (ATM) network, an internet protocol (IP), or any other packet switching network.

The communication environment 100 also includes a media gateway controller (MGC) 102, which, when coupled with a signaling gateway 162, is sometimes referred to as a "softswitch" 164. The MGC 102 communicates with an MG 104 via the packet network 106 and communication lines 132 and 142. The signaling gateway 162 communicates with the PSTN 112 via connection 136. The media gateway controller 102 may also be coupled, via the PSTN 112, to one or more other media gateway controllers, an exemplar one of which is illustrated using reference numeral 108. Further, although not shown in FIG. 1, two MGCs may communicate over the packet network 106 using, for example, the SIP protocol. The media gateway 104 also couples to the PSTN 112 via connection 144.

A first switch (switch A) 114 couples to the PSTN 112 via connection 152 and a second switch (switch B) 116 couples to the PSTN 112 via connection 154. The switches 114 and 116, are typically part of the PSTN 112, and are typically located at telephone company central offices (not shown). For exemplar purposes only, a telephone 124 couples to switch 114 via connection 156 and a telephone 122 couples to switch 116 via connection 158. The connections 156 and 158 can be any type of communication channel that typically couples telephones to telephone company central offices, and is typically a copper wire pair.

A phone 118 also couples to the media gateway 104 via connection 146. For example, the phone 118 can be an Internet phone. As known to those having ordinary skill in the art, both user traffic and signaling information typically traverse both the packet network 106 and the PSTN 112. The links 136 and 148 typically carry PSTN signaling traffic, such as signaling system seven (SS7) integrated services digital network user part (ISUP) or telephone user part (TUP) signaling messages. The connections 132, 142 typically carry packet network signaling traffic in the form of packets constructed using the media gateway control protocol (MGCP).

User traffic, for example a telephone call, that might occur between telephones 118 and 124 typically traverses communication links 146, 144, 152 and 156. Unfortunately, because the call traverses both the packet network 106 (communication line 146) and the PSTN 112 (communication lines 144, 152 and 156), the user traffic (telephone call) is identified by two different communication protocols. The packet portion of the call signaling is identified using the MGCP protocol, while the PSTN portion of the call signaling is identified using the SS7 ISUP protocol.

For example, a call setup message in the SS7 ISUP protocol would take the form of an initial address message (IAM), while a call tear-down message in the SS7 ISUP protocol would take the form of a release message (REL) or a release complete message (RLC). Conversely, in the packet network 106 using MGCP, a call setup message would take the form of a create connection (CRCX) message while a call tear-down message would take the form of a

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delete connection (DLCX) message. Further, while described using call setup and call tear-down messages, other signaling messages (that typically occur between the setup and tear-down messages) in both the SS7 and MGCP protocols will traverse the dissimilar communication networks.

In the packet network **106**, communication endpoints, such as the telephone **118** are characterized by their “end-point name,” which typically takes the form “user identifier@domain.xxx,” while in the PSTN **112**, a call is identified by a point code (PC) that relates to its origination point code (OPC), destination point code (DPC) and the circuit, identified by its circuit identification code (CIC), on which it is carried. Therefore, because the signaling used in a single phone call between telephone **118** and **124** is characterized by two separate communication protocols (SS7 ISUP on the PSTN side and MGCP on the packet side), it is difficult to provide an end to end call record, commonly referred to as a call flow record (CFR) of the single call because of the two different communication protocols used to signal the call.

In accordance with an aspect of the invention, an analysis device **200** is coupled to the packet network **106** via connection **134** and is coupled to the PSTN **112** via connection **138**. As will be described in greater detail below, the analysis device **200** includes a software code segment that allows the analysis device **200** to map the MGCP communication endpoints to the SS7 ISUP PC/CIC trunk identifiers in a manner such that a single phone call can be completely identified, and to correlate and display in real-time the MGCP and SS7 messages that correspond to and identify a particular call.

FIG. **2** is a block diagram illustrating an exemplar network analysis device **200** constructed in accordance with an embodiment of the invention. Generally, in terms of hardware architecture, as shown in FIG. **2**, the analysis device **200** includes a processor **204**, memory **206** (one or more random access memory (RAM) elements, read only memory (ROM) elements, etc.), an optional removable media disk drive **212**, an acquisition module bus interface **208**, referred to below as a “bus interface,” an input/output controller **222** and a power module **263** that are connected together and can communicate with each other via a local interface **218**. The local interface **218** can be, for example but not limited to, one or more buses or other wired or wireless connections, as is known to those having ordinary skill in the art. The local interface **218** may have additional elements, which are omitted for simplicity, such as buffers (caches), drivers, and controllers, to enable communications. Further, the local interface **218** includes address, control, and data connections to enable appropriate communications among the aforementioned components.

The processor **204** is a hardware device for executing software that can be stored in memory **206**. The processor **204** can be any suitable processor for implementing the functionality of the analysis device **200**. Preferably, the analysis device **200** executes on a SUN workstation available from SUN Microsystems.

The memory **206** can include any one or a combination of volatile memory elements (e.g., random access memory (RAM, such as DRAM, SRAM, etc.)) and nonvolatile memory elements (e.g., RAM, ROM, hard drive, tape, CDROM, etc.). Moreover, the memory **206** may incorporate electronic, magnetic, optical, and/or other types of storage media. Note that the memory **206** can have a distributed architecture, where various components are situated remote from one another, but can be accessed by the processor **204**.

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The software in memory **206** may include one or more separate programs, each of which comprise one or more code segments, which are an ordered listing of executable instructions for implementing logical functions. In the example of FIG. **2**, the software in the memory **206** includes software in the form of an analysis device application software **230** and trunk to endpoint mapping software **240**. The trunk to endpoint mapping software **240** includes message acquisition software **241**, call setup mapping software **242** and final mapping software **243**. The memory also includes tables **245**, which are created by the trunk to endpoint mapping software **240**.

In accordance with an embodiment of the invention, the analysis device application software **230** further includes correlation and real-time display of mapped trunk to endpoint identifier software **235**, referred to hereafter as “correlation and display software” **235**. The correlation and display software **235** includes real-time message acquisition software **236**, real-time call correlation software **237**, and real-time call display software **238**. The memory **206** also includes a graphical user interface (GUI) **249**. The GUI **249** processes display information from the call display software **238** for output to a user on the display **280**.

In accordance with that described in co-pending, commonly assigned U.S. patent application Ser. No. XXX (Attorney Docket No. 10011270) the trunk to endpoint mapping software **240** maps an MGCP CRCX endpoint name to a corresponding PC/CIC, and develops a PC-CIC to Endpoint mapping table, shown below in FIG. **10**. The correlation and display software **235** uses, among other items, information that is contained in the PC-CIC to Endpoint mapping table to correlate call signaling information from the two dissimilar networks into a call record and display in real-time, this information to a user of the analysis device **200**.

Although the operation of the trunk to endpoint mapping software **240** has been described in detail in co-pending, commonly assigned U.S. patent application Ser. No. XXX (Attorney Docket No. 10011270), some aspects will be repeated herein as those aspects will facilitate the description of the operation of the correlation and display software **235**.

The memory **206** also includes one or more operating software modules, collectively referred to as operating system (O/S) **210**. The O/S **210** may include software modules that perform some of the functionality of the test device **200** not specifically described herein.

In a preferred embodiment, the O/S **210** is the commonly available UNIX operating system available from SUN Microsystems. However, other operating systems may be used. The operating system **210** essentially controls the execution of other computer programs, such as the analysis device application software **230**, correlation and display software **235**, and the trunk to endpoint mapping software **240**, and provides scheduling, input-output control, file and data management, memory management, and communication control and related services. The processor **204** and operating system **210** define a computer platform, for which application programs, such as the analysis device application software **230**, correlation and display software **235**, and the trunk to endpoint mapping software **240**, are written in higher level programming languages. The correlation and display software **235** and the trunk to endpoint mapping software **240** include the executable instructions that allow the analysis device **200** to detect, decode, map, correlate and display in real-time dissimilar communication protocol messages that relate to the same user traffic.

The input/output controller **222** includes a network interface **224**, an input interface **242** and an output interface **256** each in communication with the local interface **218**. The network interface **224** couples the analysis device **200** to an external network **228** via connection **226**. The external network can be any network to which the analysis device **200** may couple to exchange information. The input interface **242** is coupled to an internal keypad **246** via connection **244** and to an external keypad **252** via connection **248**. The internal keypad **246** is located on the analysis device **200** while the external keypad **252** is an auxiliary keypad to which the test device **200** may be coupled.

The output interface **256** is coupled to a printer **262** via connection **258**. The printer **262** can be used to provide a permanent record of the analysis results obtained by the analysis device **200**. The output interface **256** also couples to a video controller **270** via connection **264**. The video controller **270** couples to a display **280** via connection **272**. The display **280** can be an LCD touch screen display capable of receiving input from a user, but may be any type of suitable display.

The disk drive **212** can be any storage element or memory device, and as used herein, generally refers to flash memory, sometimes referred to as compact flash (CF) or PC-card.

The power module **263** can power the analysis device **200** from an AC power source, or can include batteries and a built in charger to provide portable DC power.

The bus interface **208** provides both electrical and mechanical interfaces to a packet acquisition module **250** and a T1/E1 acquisition module **260**. In accordance with an aspect of the invention, the packet acquisition module **250** couples to the packet network **106** (FIG. 1) and the T1/E1 acquisition module **260** couples to the PSTN **112**. The packet acquisition module **250** monitors the packet network signaling traffic and the T1/E1 acquisition module **260** monitors the PSTN signaling traffic.

The trunk to endpoint mapping software **240** detects, decodes and stores PC/CIC information from SS7 messages and endpoint information from MGCP messages. Once the PC/CIC and endpoint name information is stored, the trunk to endpoint mapping software **240** builds a count table that maps the PSTN PC/CIC identifier to a corresponding packet network MGCP endpoint identifier. In this manner, a call record can be developed that defines both the packet network and PSTN aspects of the call. The correlation and display software **235** detects in real-time all packet network signaling messages (in this example, MGCP messages) and PSTN network signaling messages (in this example, SS7 messages), and correlates these messages into a call flow record pertaining to a single call. In other words, all messages, regardless of whether they are packet network signaling messages or PSTN network signaling messages that correspond to a particular call are displayed to a user. In this manner, a user of the analysis device can monitor, in real-time, all messages that correspond to each call traversing the dissimilar communication networks.

When the analysis device **200** is in operation, the processor **204** is configured to execute software stored within the memory **206**, to communicate data to and from the memory **206** and to generally control operations of the analysis device **200** pursuant to the software. The trunk to endpoint mapping software **240** and the correlation and display software **235** are read by the processor **204**, perhaps buffered within the processor **204**, and then executed.

When portions of the network analysis system **200** are implemented in software, as is shown in FIG. 2, it should be noted that the O/S **210**, analysis device application software

230, the correlation and display software **235**, and the trunk to endpoint mapping software **240** can be stored on any computer readable medium for use by or in connection with any computer related system or method. In the context of this document, a computer readable medium is an electronic, magnetic, optical, or other physical device or means that can contain or store a computer program for use by or in connection with a computer related system or method. The O/S **210**, analysis device application software **230**, correlation and display software **235**, and the trunk to endpoint mapping software **240** can be embodied in any computer-readable medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer-based system, processor-containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions. In the context of this document, a "computer-readable medium" can be any means that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

The computer readable medium can be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. More specific examples (a non-exhaustive list) of the computer-readable medium include the following: an electrical connection (electronic) having one or more wires, a portable computer diskette (magnetic), a random access memory (RAM) (electronic), a read-only memory (ROM) (electronic), an erasable programmable read-only memory (EPROM or Flash memory) (electronic), an optical fiber (optical), and a portable compact disc read-only memory (CDROM) (optical). Note that the computer-readable medium could even be paper or another suitable medium upon which the program is printed, as the program can be electronically captured, via for instance optical scanning of the paper or other medium, then compiled, interpreted or otherwise processed in a suitable manner if necessary, and then stored in a computer memory.

The hardware components of the network analysis system can be implemented with any or a combination of the following technologies, which are each well known in the art: a discrete logic circuit(s) having logic gates for implementing logic functions upon data signals, an application specific integrated circuit (ASIC) having appropriate combinational logic gates, a programmable gate array(s) (PGA), a field programmable gate array (FPGA), etc.

FIGS. 3 and 4 are call flow diagrams **300** and **400** illustrating the signaling messages used to setup an inbound call and an outbound call, respectively. However, prior to describing FIGS. 3 and 4, a brief overview of the SS7 and MGCP call setup and call tear-down messages will be provided. Further, while the correlation and display software **235** operates on all signaling messages that traverse the dissimilar communication networks shown in FIG. 1, for simplicity only call setup and call tear-down messages will be discussed in detail.

The trunk to endpoint mapping software **240** stores call setup signal messages and call tear-down signal messages and uses information in the messages to map an SS7 Point Code/Circuit Identification Code (PC/CIC) to a packet network endpoint name. The correlation and display software **235** detects all SS7 and MGCP messages and uses the information in the messages to correlate the messages to a call and display to a user the correlated messages in a call flow record. Further, while complete decodes of messages are illustrated below for use by the trunk to endpoint

mapping software **240**, the correlation and display software **235** may only partially decode the messages below to extract the desired information.

Call Setup Messages

In the SS7 signaling system the call setup message is the SS7 ISUP IAM and in MGCP the call setup message is the MGCP CRCX.

The trunk to endpoint mapping software **240** decodes the SS7 ISUP IAM message to extract the relevant OPC, DPC and CIC information. The following is an exemplar IAM message decode. Shown below is a full decode of the SS7 ISUP IAM message. However, because the correlation and display software **235** uses only the OPC, DPC and CIC information, the correlation and display software **235** may only partially decode the message to yield the desired terms.

BEGIN DECODE -----
BSN: 100 BIB:1 FSN:29 FIB:1 LI:54
Si/Ssf: 05/08 Dpc: 153-028-030 Opc: 146-193-014 Sls: 24
CIC: 131
MT: 01
Nature of Connection Indicators
 Satellite Indicator: No satellite circuit in the connection
 Continuity Check Indicator: Not required
 Echo control Device Indicator: Outgoing half echo device not included
Forward Call Indicators
 Incoming International Call Indicator: Not an incoming international call
 End to End Method Indicator: No end-to-end method available
 Interworking Indicator: No interworking encountered
 IAM Segmentation Indicator: No indication
 ISDN User Part Indicator: ISUP used all the way
 ISDN User Part Preference Indicator: ISUP preferred all the way
 ISDN Access Indicator: Originating access non-ISDN
 SCCP Method Indicator: No indication
 Translated Called Numb Indicator: number translated
 QoR Attempt Indicator: no QoR routing attempt in prog
 Reserved for national use: 0
Calling Party's Category: Ordinary calling subscriber
Pointer to User Service Information: 3 octets
Pointer to Called Party Number: 6 octets
Pointer to Optional Part: 13 octets
User Service Information Length: 3 octets
 Info transfer Capability: Speech
 Coding Standard: CCITT standardized
 Information Transfer rate: 64 kbit/s
 Transfer Mode: Circuit mode
 Extension Indicator: No extension
 User Info Layer 1 Protocol: Recommendation G.711 u-law speech
Called Party Number Length: 7 octets
 Nature of Address Indicator: National (significant) number
 Odd/Even Indicator: Even num of address signals
 Numbering Plan Indicator: ISDN/Telephony
 Address Signal: 9093910010
Calling Party Number Id
 Length: 7 octets
 Nature of Address Indicator: Unique national number
 Odd/Even Indicator: Even num of address signals
 Screening Indicator: Network provided
 Presentation Restriction Indicator: Presentation allowed
 Numbering Plan Indicator: ISDN/Telephony
 Address Signal: 2022372470
Charge Number Id
 Length: 7 octets
 Nature of Address Indicator: ANI of the Calling party; national number
 Odd/Even Indicator: Even num of address signals
 Numbering Plan Indicator: ISDN/Telephony
 Address Signal: 9022372470

-continued

Jurisdiction Information Id
 Length: 3 octets
 Address Signal: 202237
Timestamp: 17:01:30.65480762 GMT
END DECODE -----

Within the SS7 ISUP IAM message, and any SS7 message, three fields are significant to the invention. These are the originating point code (OPC), the destination point code (DPC), and the circuit identification code (CIC). These fields are indicated above in bold. The OPC (146-193-014) is the PC of the SS7 network entity that originated the call. The DPC (153-028-030) is the PC of the SS7 network entity that is the call destination. The CIC (131) is used to identify the specific trunk between the SS7 switches. If the OPC is equal to the PC of the softswitch **164**, then the SS7 ISUP IAM message represents an outbound call. If the DPC is equal to the PC of the softswitch **164**, then the SS7 ISUP IAM message represents an inbound call.

The trunk to endpoint mapping software **240** identifies the call identified by this SS7 ISUP IAM message by appending the CIC to the PC that is not equal to the PC of the softswitch. Consider the decode above, if the softswitch PC is 153-28-30 (equal to DPC), then the trunk to endpoint mapping software **240** will identify this SS7 ISUP IAM by the PC/CIC 146-193-14+131 (OPC+CIC). As will be described in detail below, the trunk to endpoint mapping software **240** will ultimately map the PC/CIC (146-193-14+131) to a packet network endpoint name, and the correlation and display software **235** will correlate those messages to a respective call, generate a call flow record, and display in real-time the call flow record to a user of the analysis device **200**.

The trunk to endpoint mapping software **240**, and the correlation and display software **235** decode the MGCP CRCX message to extract the relevant end point and call identification information. The following is an exemplar decode of an MGCP CRCX message. For a given SS7 ISUP IAM message, the trunk to endpoint mapping software **240** will attempt to map all MGCP CRCX messages that occur before (for an outbound call) or after (for an inbound call) the subject SS7 ISUP IAM message.

Shown below is a full decode of the MGCP CRCX message. However, because the correlation and display software **235** uses only the Endpoint information, the correlation and display software **235** may only partially decode the message to yield the desired terms.

BEGIN DECODE -----
MGCP
 Command [CRCX] : Create Connection
 Transaction ID = 12104586
 Endpoint = S4/DS1-1/1@TGR02COS.cos0.company.net
 Version = MGCP 0.1
Parameters:
 Notified Entity [N] :
mgcp.aSCT1CA.cos0.company.net:2427
 Call ID [C] : 66d3
 Local Options [L] :
 p: Packetization Period = 20,
 a: Compression Alg. = PCMU
 PCMA
 e: Echo Cancellation = on,
 s: Silence Suppression = off,
 t: Service Type = a0,

-continued

nt: Network Type = IN
Connection Mode [M] : sendrecv -- Gateway should
send and receive packets.
SDP Information -- Audio Service:
Version [v] : 0
Origin Identifiers [o] :
Username = -
Session ID = 2708
Session Version = 0
Network Type = IN
Address Type = IP4
Address = 64.213.155.8
Session Name [s] : Cisco SDP 0
Connection Data [c] :
Network Type = IN
Address Type = IP4
Connection = 64.213.155.8
Times [t] : Start = 0 Stop = 0
Media Description [m] :
Media Type = audio
Port = 16388
Transport Prot = RTP/AVP
Format(s) = 0 -- G.711: Mu-law pulse code
mod(PCMU), 1 chan audio (8 KHz)
8 -- G.711: A-law Pulse code mod.
(PCMA) 1 chan audio (8 KHz)
END DECODE -----

Two fields of interest within the MGCP CRCX message are the call ID field and the endpoint name field, both illustrated above in bold. The call ID field (66d3 in the decode above) is unique to a single call and can be used to match the MGCP CRCX call setup message with the MGCP DLCX call tear-down message (to be described below). The endpoint name field, (in this example S4/DS1-1/1@TGR02COS.cos0.company.net) identifies the endpoint to which the call is directed and also identifies the type of endpoint. The trunk to endpoint mapping software **240** uses MGCP CRCX messages in which the type of the endpoint is a trunk gateway. This endpoint name (in this example S4/DS1-1/1@TGR02COS.cos0.company.net) will be mapped to a PC/CIC. The correlation and display software **235** will use this mapping information to correlate the SS7 and MGCP messages to a call, and display a call flow record containing this information to a user of the system.

Call Tear-Down Messages

In the SS7 signaling system the call tear-down message is the SS7 ISUP REL or RLC and in MGCP the call tear-down message is the MGCP CLCX.

The trunk to endpoint mapping software **240** decodes an SS7 ISUP REL message to extract the relevant OPC, DPC and CIC information. The following is an exemplar decode of an SS7 ISUP REL message. Shown below is a full decode of the SS7 ISUP REL message. However, because the correlation and display software **235** uses only the OPC, DPC and CIC information, the correlation and display software **235** may only partially decode the message to yield the desired terms.

BEGIN DECODE -----
BSN: 53 BIB:1 FSN:100 FIB:1 LI:16
Si/Ssf: 05/09 Dpc: 153-028-030 Opc: 146-193-014 Sls: 24
CIC: 131
MT: 12
Pointer to Cause Indicators: 2 octets
Pointer to Optional Part: 0 octets
Cause Indicator Length: 2 octets

-continued

Location: Local local network
Coding Standard: CCITT standard
Cause Value: Normal clearing
Timestamp: 17:08:28.590792048 GMT
END DECODE -----

In the absence of an SS7 ISUP REL message, the trunk to endpoint mapping software **240**, and the correlation and display software **235** decodes an SS7 ISUP RLC message to extract the relevant OPC, DPC and CIC information. The following is an exemplar decode of an SS7 ISUP RLC message.

BEGIN DECODE -----
BSN: 100 BIB:1 FSN:54 FIB:1 LI:11
Si/Ssf: 05/10 Dpc: 146-193-014 Opc: 153-028-030 Sls: 3
CIC: 131
MT: 16
Timestamp: 17:08:28.602782759 GMT
END DECODE -----

The SS7 ISUP REL and SS7 ISUP RLC messages are similar. The trunk to endpoint mapping software **240** first attempts to use the SS7 ISUP REL message. If the SS7 ISUP REL message is not received, then the trunk to endpoint mapping software **240** will use the SS7 ISUP RLC message. As mentioned above, the correlation and display software **235** will decode all SS7 and MGCP messages to yield the desired terms.

As in the SS7 ISUP IAM message, three fields are of interest in the SS7 ISUP REL/RLC messages are the OPC field, the DPC field, and the CIC field. The trunk to endpoint mapping software **240** identifies this message by appending the CIC to the PC that is not equal to the PC of the softswitch PC. Consider the SS7 ISUP REL decode above. If the softswitch PC is 153-28-30 (equal to DPC), then the trunk to endpoint mapping software **240** identifies this SS7 ISUP REL by the PC/CIC 146-193-14+131 (OPC+CIC). The trunk to endpoint mapping software **240** can then map the SS7 ISUP REL call tear-down message to a single SS7 ISUP IAM call setup message. The correlation and display software **235** can then use this information, among other items, to correlate each of the signaling messages to a particular call. This information is then displayed to a user, in real-time, as a call flow record that includes all signaling messages that relate to a particular call.

The trunk to endpoint mapping software **240** and the correlation and display software **235** decode an MGCP DLCX message (or any MGCP message) to obtain the relevant endpoint name and call ID information. The following is an exemplar decode of an MGCP DLCX message. The MGCP DLCX message is associated with an MGCP CRCX message by the Call ID field. Shown below is a full decode of the MGCP CRCX message. However, because the correlation and display software **235** uses only the Endpoint and Call ID information, the correlation and display software **235** may only partially decode the message to yield the desired terms.

```

BEGIN DECODE -----
MGCP
  Command [DLCX] : Delete Connection
  Transaction ID  = 12104588
  Endpoint       = S4/DS1-1/1@TGR02COS.cos0.company.net
  Version        = MGCP 0.1
Parameters:
  Connection ID   [I] : 4C7D2
  Call ID         [C] : 66d3
Timestamp: 17:25:44.636891809 GMT
END DECODE -----

```

The Call ID field is of significance to the trunk to endpoint mapping software **240**. The call ID field (66d3 in the decode above) uniquely maps the MGCP DLCX call tear-down message to a single MGCP CRCX call setup message.

Inbound Calls

The trunk to endpoint mapping software **240** distinguishes between inbound calls and outbound calls. Inbound calls are calls originated outside the softswitch **164**. Accordingly, with an inbound call, an SS7 ISUP IAM message is sent to the softswitch **164**. In such a case, the DPC of the SS7 ISUP IAM message will be equal to the PC of the softswitch **164**. The trunk to endpoint mapping software **240** detects, decodes and stores the OPC+CIC from the SS7 ISUP IAM message so that it can be mapped to an MGCP endpoint name (trunk gateway).

Referring now to FIG. 3, the call diagram **300** depicts the call setup messages transferred when establishing an inbound call. FIG. 3 includes messages transferred among switch A **114**, MGC **102** (softswitch **164**), MG **104** and phone **118**, all of FIG. 1. Each message contains a number that represents the delta time in milliseconds from the first message. The delta time varies between calls depending on network traffic and congestion, and the numbers illustrated represent an approximate time span between messages.

At time “0” the switch A **114** sends an SS7 ISUP IAM message to the softswitch **164**. At time “+45” the softswitch **164** sends an CRCX message to the MG **104**. At time “+65” the MGCP CRCX message sent to the MG **104** causes the phone **118** to ring. Note that the SS7 ISUP IAM comes before the MGCP CRCX in an inbound call.

Outbound Calls

An outbound call originates from the MGC (softswitch). Accordingly, an SS7 ISUP IAM message is sent from the MGC (softswitch). In this case, the OPC of the SS7 ISUP IAM message will be equal to the PC of the softswitch **164**. The trunk to endpoint mapping software **240** stores the DPC+CIC from the SS7 ISUP IAM message and maps the DPC+CIC to an MGCP endpoint name (trunk gateway). The correlation and display software analyzes and correlates these messages to a respective call so they can be presented, in real-time, to a user in a call flow record.

Referring now to FIG. 4, the call diagram **400** depicts the call setup messages transferred when establishing an outbound call. As described above with respect to FIG. 3, each message contains a number that represents the delta time in milliseconds from the first message. The delta time varies between calls depending on traffic and network congestion, and the numbers illustrated represent an approximate time span between messages. At time “0” the phone **118** sends an MGCP notify (NTFY) message to the softswitch **164**. At time “32” the softswitch **164** sends an MGCP CRCX message to the MG **104**. At time “65” the softswitch **164** sends

an SS7 ISUP IAM message to the switch A **114**. Note that the MGCP CRCX comes before the SS7 ISUP IAM message in an outbound call.

FIGS. **5A** and **5B** collectively illustrate a call sequence diagram **500** of three exemplar calls that will be used to illustrate the operation of certain embodiments of the invention. Although only call setup and call tear-down messages are illustrated, it should be mentioned that many signaling messages will occur between the call setup and call tear-down messages for each call and the correlation and display software **235** will act on these messages as well. The message acquisition software **241** detects, decodes and stores all call setup (SS7 ISUP IAM and MGCP CRCX) and call tear-down messages (SS7 ISUP REL/RLC and MGCP DLCX). The real-time message acquisition software **236** detects, decodes and stores all SS7 and MGCP messages.

Prior to discussing the operation of the correlation and display software **235**, the operation of the trunk to endpoint mapping software **240** will be described. As mentioned above, the correlation and display software **235** uses, among other items, information contained in the PC/CIC to Endpoint mapping table (shown in FIG. 10), to correlate and display to a user in real-time all call signaling messages that correspond to each call traversing the dissimilar communication networks (FIG. 1).

Operation of the Trunk to Endpoint Mapping Software **240**

All SS7 ISUP IAM messages in which the OPC or DPC is equal to a known MGC (softswitch) PC are stored in a list. The following Table 1 illustrates a list of IAM messages using the call sequence of FIGS. **5A** and **5B**.

TABLE 1

| SS7 ISUP IAM Message List | |
|---------------------------|--|
| SS7 ISUP IAM Call #1 | |
| DPC: 153-28-30 | |
| OPC: 146-193-14 | |
| CIC: 131 | |
| Timestamp: 00000 ms | |
| SS7 ISUP IAM Call #2 | |
| DPC: 221-53-42 | |
| OPC: 153-28-30 | |
| CIC: 22 | |
| Timestamp: 00063 ms | |
| SS7 ISUP IAM Call #3 | |
| DPC: 153-28-30 | |
| OPC: 146-193-14 | |
| CIC: 133 | |
| Timestamp: 00088 ms | |
| ... | |

Each MGCP CRCX message has a source and a destination. Because MGCP CRCX messages in which the destination is a trunk (media) gateway (MG) are being mapped to the PC/CIC, the message acquisition software **241** analyzes the MGCP CRCX message if the destination is a media gateway. MGCP CRCX messages in which the endpoint is an MG (such as MG **104** of FIG. 1) are stored in a list. When the analysis device **200** receives an MGCP CRCX message, the message acquisition software **241** analyzes the “Endpoint” field in the MGCP CRCX message and determines the type of the endpoint by, for example, a table lookup or the use of regular expressions.

1. Table Lookup

An MGCP CRCX message is a user datagram protocol (UDP) message. A UDP message is embedded within an IP message. In the IP header of the IP message, the source IP address and the destination IP address are given. The des-

tination IP address (for example, 130.29.44.199) is the endpoint of the MGCP CRCX message. It should be noted that while the MGCP CRCX message decode illustrated above shows a decode of an MGCP CRCX message, this decode does not show the IP header information and therefore does not show the source and destination IP addresses. Having the destination IP address allows a table lookup to be performed. Using the IP header information including the source and destination IP addresses, a table containing two (2) columns and multiple rows can be created. Each row contains an IP address in the first column and an endpoint type in the second column. Given an IP address, the trunk to endpoint mapping software **240** can look in the table for a matching IP address and subsequently get the corresponding endpoint type if the IP address is found.

2. Regular Expressions

As known to those having ordinary skill in the art, the term “regular expressions” refers to pattern descriptions that enable matching of identifier strings to the “regular expression.” Each MGCP CRCX message has an associated endpoint name. For example, in the decode of the MGCP CRCX message illustrated above, the MGCP CRCX message decode includes the endpoint name “S4/DS1-1/1@TGR02COS.cos0. company.net”.

For a given network, all MGCP CRCX messages in which the endpoint is a trunk gateway will have a similar pattern in the name with few variations. Knowing, or estimating, this pattern, it is possible to define a regular expression that can be used to evaluate the MGCP CRCX endpoint name and conclude if the endpoint type is a trunk gateway. Therefore, given the trunk endpoint names used in this document as examples in the MGCP CRCX messages, one would come up with the following regular expression to evaluate if the MGCP CRCX endpoint is a trunk gateway:

“S([0-9])(.*)DS(.*)@TGR02COS.cos0.company.net.”

The following Table 2 shows a list of MGCP CRCX messages from the call sequence diagram of FIGS. 5A and 5B.

TABLE 2

| MGCP CRCX Message List | |
|--|--|
| MGCP CRCX Call #1 | |
| Endpoint: S4/DS1-1/1@TGR02COS.cos0.company.net | |
| Call ID: 66d3 | |
| Timestamp: 00045 ms | |
| MGCP CRCX Call #2 | |
| Endpoint: S4/DS1-2/2@TGR02COS.cos0.company.net | |
| Call ID: 65e1 | |
| Timestamp: 00046 ms | |
| MGCP CRCX Call #3 | |
| Endpoint: S4/DS1-3/3@TGR02COS.cos0.company.net | |
| Call ID: 51c2 | |
| Timestamp: 00112 ms | |
| ... | |

The message acquisition software **241** stores SS7 ISUP REL messages that meet the following conditions. The DPC or OPC is equal to the PC of the softswitch **164**, and the associated PC/CIC maps to an active SS7 ISUP IAM message. An active SS7 ISUP IAM Message is one in which the PC/CIC can be found in the LAM list (Table 1) or the PC/CIC-MGCP CRCX hash map (Table 5 below) and in which the call tear-down messages have yet to be received. Only SS7 ISUP REL/RLC messages that can be associated

with an active SS7 ISUP IAM message are stored for final mapping by the final mapping software **243**.

When the above mentioned conditions are satisfied the SS7 ISUP REL message will be stored in a hash map (Table 3) in which the PC/CIC is the key and the message is the value. Table 3 shows the SS7 ISUP REL hash map using call data from the call sequence diagram shown in FIGS. 5A and 5B.

TABLE 3

| SS7 ISUP REL Message Hash Map | | |
|-------------------------------|--|--|
| Key | Value | |
| 146-193-14 + 131 (Call #1) | DPC: 153-28-30 OPC: 146-193-14 CIC: 131 Timestamp: 30102 ms | |
| 221-53-42 + 22 (Call #2) | DPC: 221-53-42 OPC: 153-28-30 CIC: 22 Timestamp: 21511 ms | |
| 146-193-14 + 133 (Call #3) | DPC: 153-28-30 OPC: 146-193-14 CIC: 133 Timestamp: 42313 ms | |
| 146-193-14 + 133 (Call #3) | DPC: 153-28-30 OPC: 146-193-14 CIC: 133 Timestamp: 42313 ms | |
| ... | | |

An SS7 ISUP RLC message is handled similar to an SS7 ISUP REL message. An SS7 ISUP RLC message is stored under the same conditions and in the same manner as an SS7 ISUP REL message. An SS7 ISUP RLC message is used if an SS7 ISUP REL message is not received for a given call.

The message acquisition software **241** stores MGCP DLCX messages that have a call ID field that is equal to the call ID field of an active MGCP CRCX message. An active MGCP CRCX message is one in which the call ID field can be found in the MGCP CRCX list (Table 2) or in the PC/CIC-MGCP CRCX hash map (Table 5 below) and in which a call tear-down message has yet to be received.

Only an MGCP DLCX message that can be associated with an active MGCP CRCX message is stored for use by the final mapping software **243**. The MGCP DLCX message will be stored in a hash map (Table 4) in which the call ID field is the key and the message is the value. Table 4 shows the MGCP DLCX hash map using message information from the call sequence diagram shown in FIGS. 5A and 5B.

TABLE 4

| MGCP DLCX Message Hash Map | | |
|----------------------------|--------------------------------------|--|
| Key | Value | |
| 66d3 (Call #1) | Call ID: 66d3 Timestamp: 30107 ms | |
| 65e1 (Call #2) | Call ID: 65e1 Timestamp: 21503 ms | |
| 51c2 (Call #3) | Call ID: 51c2 Timestamp: 42318 ms | |

With reference now to FIGS. 5A and 5B, the operation of the call setup mapping software **242** (FIG. 2) will be described. The call set up mapping software **242** keys on the SS7 ISUP IAM messages (i.e., the SS7 call setup messages) from Table 1 above. For each message in the SS7 ISUP IAM list, the call setup mapping software **242** associates all

MGCP CRCX (MGCP call setup) messages that occur within a predetermined amount of time (IAM_CRCX_delta time) before (for an outbound call) or after (for an inbound call) the detection of the SS7 ISUP IAM message. The results of the mapping are stored in a hash map (Table 5 below) with the SS7 ISUP LAM PC/CIC as the key and a list of closely occurring MGCP CRCX messages in the value field.

Preferably the IAM_CRCX_delta_time value is 2000 ms, however, depending on the network, other delta time values may be possible. The following Table 5 shows the PC/CIC-MGCP CRCX hash map that stores PC/CIC and associated MGCP CRCX messages.

TABLE 5

| PC/CIC - MGCP CRCX Hash Map | |
|-------------------------------|--|
| Key | Value |
| 146-193-14 + 131 (Call #1) | Endpoint: S4/DS1-/ 1@TGR02COS.COS0.company.net Call ID: 66d3 Timestamp: 00045 ms (Call #1) Endpoint: S4/DS1- 2/2@TGR02COS.cos0.company.net Call ID: 65e1 Timestamp: 00046 ms (Call #2) Endpoint: S4/DS1- 3/3@TGR02COS.cos0.company.net Call ID: 51c2 Timestamp: 00112 ms (Call #3) |
| 221-53-42 + 22 (Call #2) | Endpoint: S4/DS1- 1/1@TGR02COS.cos0.company.net Call ID: 66d3 Timestamp: 00045 ms (Call #1) Endpoint: S4/DS1- 2/2@TGR02COS.cos0.company.net Call ID: 65e1 Timestamp: 00046 ms (Call #2) |
| 146-193-14 + 133 (Call #3) | Endpoint: S4/DS1- 3/3@TGR02COS.cos0.company.net Call ID: 51c2 Timestamp: 00112 ms (Call #3) |
| ... | |

Based on the call sequence diagram in FIGS. 5A and 5B, three entries are shown in Table 5, one entry for each call. Call #1 is identified by the PC/CIC 146-193-14+131.

Call #1 originates in switch A 114 and is an inbound call (the DPC of the IAM message equals the PC of the MGC 102 (softswitch 164). Therefore, the call setup mapping software 242 associates all MGCP CRCX messages (originating from the MGC 102 (softswitch 164)) occurring within IAM_CRCX_delta_time after the SS7 ISUP IAM message (call #1) with the SS7 ISUP IAM message of call #1. If IAM_CRCX_delta_time is 2000 ms, all three MGCP CRCX messages in the call sequence diagram 500 are associated with 146-193-14+131 (the PC/CIC of the SS7 ISUP IAM message of call #1).

Call #2 is identified by the PC/CIC 221-53-42+22. Call #2 originates from a phone (or other communication device) coupled to the MG 104, and is an outbound call. Therefore, the call setup mapping software 242 associates MGCP CRCX messages occurring within IAM_CRCX_delta_time before the SS7 ISUP IAM message (for call #2). If IAM_CRCX_delta_time is 2000 ms, the MGCP CRCX

messages from Call #1 and Call #2 are associated with PC/CIC 221-53-42+22 (the PC/CIC of the switch B 116).

Call #3 is identified by the PC/CIC 146-19-14+133. Call #3 is similar to call #1 in that it is an inbound call (the DPC of the IAM message equals the PC of the MGC 102 (softswitch 164) originating in switch A 114. The MGCP CRCX from call #3 is the only MGCP CRCX message occurring within IAM_CRCX_delta_time after the SS7 ISUP IAM message of call #1.

FIGS. 6A through 6C comprise a flowchart 600 collectively illustrating the operation of the message acquisition software 241 of FIG. 2. In block 602 the message acquisition software 241 detects a communication message. In block 604 it is determined whether the communication message is an SS7 ISUP message. If the message is not an SS7 ISUP message, then the process proceeds to block 622, as will be described below. If, however, in block 604 it is determined that the communication message is an SS7 ISUP message, then, in block 606 it is determined whether the message is an IAM message. If it is determined in block 606 that the message is not an IAM message, then, in block 612 it is determined whether the SS7 ISUP message is an REL, (or an RLC) message.

If it was determined in block 606 that the SS7 ISUP message is an IAM message, then, in block 608 the message acquisition software 241 determines whether the OPC or the DPC of the IAM message equals the point code (PC) of the softswitch 164. If, in block 608 it is determined that either the OPC or the DPC of the IAM message equals the PC of the softswitch 164, then, in block 610, the IAM message is stored in the SS7 ISUP IAM message list (Table 1). The process then proceeds back to step 602. If the answer to the question in block 608 is negative, then, the process returns to block 602.

In block 612 it is determined whether the SS7 ISUP message is a call tear-down message (i.e., either an SS7 ISUP REL or RLC message). If the message is an REL or an RLC message, then, in block 614, the message acquisition software 241 determines whether the OPC or the DPC of the REL (or RLC) message equals the PC of the softswitch 164.

If, in block 614, it is determined that the OPC or the DPC of the REL (RLC) message equals the PC of the softswitch 164, then, in block 616 it is determined whether the REL (RLC) message maps to an active call. In other words, it is determined whether the PC of the REL (RLC) message can be found in Table 1 or Table 5. If the answers to the questions in either block 614 or 616 are negative, then, the process proceeds to block 602.

If, in block 616, it is determined that the REL (RLC) message maps to an active call, then, in block 618, the REL message is stored in the SS7 ISUP REL message hash map (Table 3). If the message is an RLC message, then it would be stored in a similar table. The process then reverts to block 602.

In block 622, and assuming that in block 604 the message was determined not to be an SS7 ISUP message, it is determined whether the message is an MGCP message. If the message is not an MGCP message, then the process reverts to block 602. If, however, in block 622 it is determined that the message is an MGCP message, then, in block 624, it is determined whether the MGCP message is a call setup message (i.e., a CRCX message). If it is determined in block 624 that the MGCP message is a CRCX message, then, in block 626, it is determined whether the MGCP end point is a gateway. If, in block 624 it is determined that the message is not a CRCX message, then the process proceeds to block 632, as will be described below.

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If, in block **626**, it is determined that the MGCP end point is a gateway, then, in block **628**, the CRCX message is stored in the MGCP CRCX message list (Table 2). If the answer to the question in block **626** is negative, then the process reverts to block **602**.

In block **632**, assuming that in block **624** it was determined that the MGCP was not a CRCX message, it is determined whether the MGCP message is a DLCX message. If it is determined in block **632** that the message is a DLCX message, then, in block **634** it is determined whether the DLCX message maps to an active call. In other words, it is determined whether the call ID of the DLCX message can be found in the MGCP CRCX message list (Table 2). If the answer to the question in block **634** is yes, then, in block **636**, the DLCX message is stored in the MGCP DLCX message hash map (Table 4). If it is determined in block **634** that the DLCX message does not map to an active call, then, the process reverts to block **602**. In block **638** it is determined whether there is another message. If there is not another message the process ends. If another message exists, then the process reverts back to block **602**.

FIGS. 7A through 7C comprise a flowchart **700** collectively illustrating the operation of the setup message software **242** of FIG. 2. In block **702** the setup message software **242** obtains an IAM message from the SS7 ISUP IAM message list (Table 1).

In block **704** it is determined whether the IAM message is either an outbound message or is outside of the time threshold "IAM_CRCX_delta_time." If the IAM message is neither outbound nor is outside of the time threshold "IAM_CRCX_delta_time," the process returns to **702**, whereby the setup message software **242** obtains the next IAM message from Table 1. If the IAM message is outbound or is outside of the time threshold "IAM_CRCX_delta_time," in block **706**, the IAM message is removed from the SS7 ISUP IAM message list (Table 1) and the process proceeds to block **708**.

In block **708**, it is determined whether a CRCX message exists in Table 2. If this is the first IAM (block **702**) and the answer is no, then, in block **709**, the PC/CIC is extracted from the IAM and added to the PC/CIC-MGCP CRCX hash map (Table 5). If the answer to the question in block **708** is no for a subsequent IAM message, then the process reverts to block **702**. If it is determined in block **708** that a CRCX message does exist, then, in block **710**, the CRCX message is obtained from the MGCP CRCX message list (Table 2).

In block **712** it is determined whether the CRCX message is beyond the threshold "IAM_CRCX_delta_time." If the CRCX message is not beyond the threshold "IAM_CRCX_delta_time," then the process jumps to block **718**, which will be described below. If, however, the CRCX message is beyond the threshold "IAM_CRCX_delta_time," then, in block **716**, the CRCX message is removed from the MGCP CRCX message list (Table 2).

If it was determined in block **712** that the CRCX message is not beyond the threshold "IAM_CRCX_delta_time," then, in block **718**, it is determined whether the IAM message is outbound and whether the CRCX message is received within the threshold "IAM_CRCX_delta_time" before the IAM message. If the answer to the question in block **718** is no, then the process proceeds to block **724**, which will be described in further detail below. If, however, the answer to the question in block **718** is yes, then, in block **722**, the IAM PC/CIC and the CRCX is stored in the PC/CIC-MGCP CRCX hash map (Table 5) and the process reverts to block **708**.

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If the answer to the question in block **718** was no, then, in block **724**, it is determined whether the LAM message is inbound and whether the CRCX message was received within the threshold "IAM_CRCX_delta time" after the IAM message. If the answer to the question in block **724** is no, then the process returns to block **708**. If, however, the answer to the question in block **724** is yes, then, in block **726**, the setup message software **242**, stores the IAM PC/CIC and CRCX in the PC/CIC-MGCP CRCX hash map (Table 5).

In block **728** it is determined whether another IAM message exists in the SS7 ISUP IAM message list (Table 1). If yes, then the process returns to block **702**. If not, the process ends.

FIGS. 8A and 8B comprise a flowchart **800** collectively illustrating the operation of the final mapping software **243** of FIG. 2. In block **802** the final mapping software **243** obtains a PC/CIC from the PC/CIC-MGCP CRCX hash map (Table 5) above. In block **804** it is determined whether an SS7 ISUP REL call tear-down message has been detected by the message acquisition software **241**. If a call tear-down message has not been received then the process returns to block **802** to obtain the next PC/CIC from the PC/CIC-MGCP CRCX hash map (Table 5).

If an SS7 ISUP REL (or RLC) has been detected in block **804**, then, in block **806**, the final mapping software **243** obtains an MGCP CRCX message (Table 5) for the current PC/CIC obtained in step **802**. If no CRCX message is associated with the subject IAM message, then a "NULL" is mapped to the PC/CIC of the IAM.

In block **808** it is determined whether an MGCP DLCX call tear-down message has been detected by the message acquisition software **241**. If not, then the process returns to block **806**. If, however, in block **808** an MGCP DLCX call tear-down message has been detected, then, in block **810**, it is determined whether the MGCP DLCX message occurred within the time threshold REL DLCX_delta_time, either before or after the receipt of the corresponding SS7 ISUP REL (or RLC) message.

If, in block **810**, the MGCP DLCX message did not occur within the prescribed time threshold the message is ignored, and the process returns to block **806** for the next MGCP CRCX message. However, if the MGCP DLCX message did occur within the prescribed time period either before or after the receipt of the SS7 ISUP REL (or RLC) (tear-down) message, then, in block **812**, the final mapping software **243** will map the MGCP CRCX endpoint name to the corresponding PC/CIC. This is illustrated in FIG. 10, which illustrates a mapping table **1000**. In FIG. 10, the PC/CIC 146-193-14+131 is mapped to the endpoint S4/IDS1-1/1@TGR02 COS.cos0.company.net.

In block **814** it is determined whether another MGCP CRCX message is associated with the subject PC/CIC. If yes, then the process proceeds back to block **806**. If there is not another MGCP CRCX message associated with the subject PC/CIC, then the process proceeds to block **818**. In block **818** it is determined whether there is another PC/CIC in Table 5. If there is another PC/CIC to which an MGCP endpoint is to be mapped, then the process returns to block **802** and obtains the next PC/CIC from the hash map Table 5 and the process in FIGS. 8A and 8B is repeated. If the last PC/CIC has been analyzed, then the process ends.

FIGS. 9A, 9B and 9C collectively illustrate a flowchart **900** showing the operation of certain embodiments of the invention with regard to the three calls illustrated in FIGS. 5A and 5B. In block **902**, the final mapping software **243** obtains the call #1 PC/CIC (146-193-14+131) from the

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PC/CIC-MGCP CRCX hash map (Table 5). In block 904, the final mapping software 243 performs a lookup operation in the SS7 ISUP REL hash map (Table 3) for an entry having a PC/CIC equal to 146-193-14+131. This lookup returns the call #1 SS7 ISUP REL message having a timestamp equal to 30102 ms. (See FIG. 5B).

In block 906, the final mapping software 243 obtains the first MGCP CRCX message, which corresponds to the SS7 ISUP REL message having the PC 146-193-14+131, from the value field in the PC/CIC-MGCP CRCX hash map (Table 5). This corresponds to the call #1 MGCP CRCX message having a call ID of 66d3 and the endpoint name S4/DS1-1/1@TGR02COS.cos0.company.net.

In block 908, given the call ID 66d3 found above in block 906, the final mapping software 243 performs a lookup in the MGCP DLCX hash map (Table 4) and obtains the MGCP DLCX (the MGCP call tear-down) message for call #1 having the timestamp 30107 ms.

In block 910 it is determined whether the MGCP DLCX time stamp (30107 ms) is within a threshold value (2000 ms (REL_DLCX_delta_time)) from the time that the SS7 ISUP REL message was received (timestamp 30102). If the answer to block 910 is no, then the final mapping software 243 will get the next MGCP CRCX message (block 916 in FIG. 9B), and perform steps 906, 908, 910, 912 and 914. If however, the answer to block 910 is yes, then, in block 912, the final mapping software 243 will map the call #1 endpoint name S4 DS1-1 @TGRO2 COS.cos 0. company.net to the call #1 SS7 ISUP IAM PC/CIC 146-193-14131. This is illustrated in the table 1000 shown in FIG. 10.

In block 918, it is determined whether there are any additional MGCP CRCX messages in the PC/CIC-MGCP CRCX hash map (Table 5) associated with the PC/CIC of call #2 (146-193-14+131). If not, the process continues to block 928. If the answer to the query in block 918 is yes, then, in block 920, the final mapping software 243 obtains the next MGCP CRCX (call #3 having call ID 51c1) and performs steps 906, 908, 910, 912 and 914.

In block 922, it is determined whether there are any additional MGCP CRCX messages in the PC/CIC-MGCP CRCX hash map (Table 5) associated with the PC/CIC of call #3 (146-193-14+131). If not (as in this example), the process continues to block 926. If the answer to the query in block 922 is yes, then, the process returns to block 906.

In block 926 it is determined whether there is another PC/CIC in the PC/CIC-MGCP CRCX hash map (Table 5). If no, then the process ends. If the answer is yes, then, in block 928, the final mapping software 243 obtains the next PC/CIC (call #2 PC/CIC having a value of 221-53-42+22) from the PC/CIC-MGCP CRCX hash map (Table 5) and repeats steps 904 through 926, thereby mapping the call #2 endpoint name S4/DS1-2/2@TGR02COS.cos0. company.net to the call #2 SS7 ISUP IAM PC/CIC 221-53-42+22. This is illustrated in the table 1000 shown in FIG. 10.

In block 932 it is determined whether there are any additional PC/CICs. If not, then the process ends. If the answer is yes, then, in block 934, the final mapping software 243 obtains the next PC/CIC (call #3 PC/CIC having a value of 146-193-14+133) from the PC/CIC-MGCP CRCX hash map (Table 5) and repeats steps 906 through 932, thereby mapping the call #3 endpoint name S4/DS 1-3/3@TGR02COS.cos0.company.net to the call #3 SS7 ISUP IAM PC/CIC 146-193-14+133. This is illustrated in the table 1000 shown in FIG. 10.

In block 936 it is determined whether there are any additional PC/CICs. If not, then the process ends. If yes, then the process returns to step 902.

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FIG. 11 is a chart 1100 illustrating a sample result obtained from the operation of the trunk to endpoint mapping software 240 (FIG. 2). Given the information in the Table 1100, a user of the system can consider the likelihood that an endpoint name correctly maps to a particular PC/CIC. For example, the PC/CIC 146-193-14+133 shows that it was mapped to two endpoints and to no endpoint (NULL). The PC/CIC 146-193-14+133 was mapped a total of 114 times. It was mapped 77 times to the endpoint S4/DS1-3/3@TGR02COS.cos0.company.net, three (3) times to no endpoint, and 34 times to the endpoint S4/DS1-2/2@TGR02.COS.cos0.company.net.

Given this information, a user could likely infer that the endpoint S4/DS1-3/3@TGR02.COS.cos0.company.net is the correct endpoint to be mapped to the PC/CIC 146-193-14+133.

Operation of the Correlation and Display Software 235

Following is a description of the operation of the correlation and display software 235. FIGS. 12 and 13 (A and B), describe the operation of the real-time message acquisition software 236 and the real-time call correlation software 237, respectively, as they pertain to an SS7 message. Similarly, FIGS. 15 and 16 (A and B), describe the operation of the real-time message acquisition software 236 and the real-time call correlation software 237 respectively, as they pertain to an MGCP message. FIG. 14 describes the operation of the real-time call display software 237 and applies to both SS7 messages and to MGCP messages.

FIG. 12 is a flowchart 1200 describing the operation of the real-time message acquisition software 236 of FIG. 2. In block 1202 an SS7 message is detected using the T1/E1 acquisition module 260 (FIG. 2). In block 1204, the detected SS7 message is stored in memory.

FIGS. 13A and 13B comprise a flowchart 1300 collectively illustrating the operation of the real-time call correlation software 237 of FIG. 2. In block 1302, the PC/CIC of the remote switch (i.e. the switch represented by the DPC in messages that are outbound and by the OPC in messages that are inbound) is extracted from the message. For example, referring back to the mapping table 1000 (FIG. 10), the PC/CIC 146-193-14+131 is removed from the SS7 message that was stored to memory in block 1204 (FIG. 12).

In block 1304, the extracted PC/CIC is stored in memory. In block 1306 it is determined whether a call reference exists for this PC/CIC. This is determined by querying the table of currently established SS7 calls (shown below in Table 6). The presence of a call reference in Table 6 indicates that this message is part of an existing call.

TABLE 6

| Currently Established SS7 Calls | |
|------------------------------------|-----------|
| PC/CIC | Call Ref. |
| 146-193-14 + 131 | 434 SXD |

If it is determined in block 1306 that a call reference does exist for this PC/CIC, then, in block 1312, the SS7 message is added to the existing call. This is illustrated below in FIG. 17, which illustrates an exemplar call flow record (CFR) for a particular call. After block 1312, the process proceeds to block 1336, which will be described in detail below.

If, in block 1306, it was determined that a call reference does not exist for the call (indicating that the message does not correspond to an existing call), then, in block 1316, a

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new call structure is created in memory. In block 1318, the call is added to the global call map (shown below in Table 7). The global call map is a table that references all of the calls monitored by the correlation and display software 235.

TABLE 7

| Global Call Map | |
|-----------------|---------------|
| Call Ref. | Call Object |
| 434SXD | Call Object 1 |
| 468SEH | Call Object 2 |

As shown above in Table 7, each call reference (for example the call reference identifier 434SXD) is associated with a call object referred to as “Call Object 1”. In this manner, the new call is added to the global call map (Table 7).

In block 1322, a unique call reference is added to the table of currently established SS7 calls using the PC/CIC of the call as an index value, if it does not already exist in this table. This is illustrated in Table 6, where the PC/CIC 146-193-14+131 is indexed to the call reference 434SXD.

In block 1326, the MGCP endpoint name that corresponds to the PC/CIC 146-193-14+131 is retrieved from the mapping table 1000 shown in FIG. 10.

As illustrated using the mapping table 1000, the endpoint name S4/DS1-1/1@TGR02COS.cos0.company.net corresponds to the PC/CIC 146-193-14+131, and is thereby retrieved.

In block 1328, if it does not already exist, the unique call reference 434SXD is added to the table of currently established MGCP calls (Table 8), as shown below, using the MGCP endpoint name S4/DS1-1/1@TGR02COS.cos0.company.net as the index value.

TABLE 8

| Currently Established MGCP Calls | |
|--------------------------------------|-----------|
| Endpoint | Call Ref. |
| S4/DS1-1/1@TGR02COS.cos0.company.net | 434 SXD |

In block 1334, the SS7 message detected in block 1202 and stored in memory in block 1204 (FIG. 12) is added to the new call that was created in blocks 1316 through 1328.

In block 1336 it is determined whether the message is a call tear-down message. For example, the real-time call correlation software 237 determines whether the SS7 message detected in block 1202 (FIG. 12) is an RLC, REL or a reset connection (RSC) message. If the message is not a call tear-down message, then the process proceeds to a “listen,” or “wait” state 1338. When a new message is detected, the process returns to block 1302.

If, however, it is determined in block 1336 that the message is a call tear-down message, then, in block 1342, the PC/CIC of the call is removed from the table of currently established SS7 calls (Table 6). In block 1344, the call is removed from the global call map (Table 7), and, in block 1348, the call is marked to be removed from the display (see FIGS. 14 and 17).

FIG. 14 is a flowchart 1400 describing the operation of the real-time call display software 238 of FIG. 2. In block 1402 it is determined whether a new call is created with this particular message. If a new call is created with this par-

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ticular message (i.e., the message detected in block 1202 and stored in memory in block 1204 (FIG. 12)), then, in block 1406 a new folder is added to the display shown in FIG. 17. In block 1412, the display is updated by adding this message. If, however, in block 1402 a new call is not created with this message, then block 1406 is bypassed and, in block 1412, the display is updated by adding this particular message.

In block 1414 it is determined whether this message is the last message of a call. If this is not the last message, then the process returns to block 1402. If this is the last message, then, in block 1418, the folder is removed from the display. Alternatively, completed calls may remain in the display for a user determined period of time so that a user may view completed calls in the display for a period of time beyond the receipt of the call’s last message. A “grace” period may or may not be defined by the user to allow completed calls to remain in the display for this purpose.

FIG. 15 is a flowchart 1500 describing the operation of the real-time message acquisition software 236 (FIG. 2) as it pertains to an MGCP message. In block 1502 the packet acquisition module 250 detects an MGCP message. In block 1504 the MGCP message is stored to memory.

FIGS. 16A and 16B comprise a flowchart 1600 collectively illustrating the operation of the real-time call correlation software 237 as it pertains to an MGCP message that includes an endpoint name. However, some MGCP messages have endpoints and some do not. In accordance with embodiments of the present invention, only messages that contain an endpoint, and therefore, endpoint name, are correlated to SS7 messages. However, it is also possible to associate an MGCP message that does not contain an endpoint name to a call record and call display. Accordingly, although not specifically addressed in this document, all MGCP messages and all SS7 messages can be included in a displayed call, regardless of whether these messages contribute to the correlation between an MGCP message and an SS7 message. Therefore, an MGCP message that does not contain an endpoint name is included in the call, and is also included in the call display, to which the message is associated.

Associating an MGCP message (with or without an endpoint name) to a call is not necessarily related to correlating MGCP messages to SS7 messages. Accordingly, associating an MGCP message to a call is outside of the scope of the present invention, and will not be described in detail.

FIG. 16A begins with the step of extracting an endpoint name from an MGCP message. In block 1602, the MGCP endpoint name is extracted from the message received in block 1502 (FIG. 15). For example, the MGCP endpoint name S4/DS1-1/1@TGR02COS.cos0.company.net is extracted from the received message.

In block 1604 it is determined whether a call reference exists for this endpoint name. This is determined by querying the table of currently established MGCP calls (Table 8). If a call reference does exist for this endpoint name, then, in block 1608, the message is added to the existing call. In block 1612 it is determined whether the message is destined for a media gateway, such as media gateway 104 (FIG. 1). If the message is not destined for a media gateway, then the process proceeds to block 1642 where the message is added to the call. MGCP messages that are not destined for a media gateway do not contain information that contributes to the correlation process.

If, however, it is determined in block 1612 that the message is destined for a media gateway, such as media gateway 104, then, in block 1614, the PC/CIC that corre-

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sponds to the MGCP endpoint name is located in the mapping table **1000** (FIG. **10**), using the MGCP endpoint name. For example, the PC/CIC 146-193-14+131 corresponds to the MGCP endpoint name S4/DS1-1/1@TGR02COS.cos0.company.net.

In block **1618**, a unique call reference is added to the table of all currently established SS7 calls (Table 6) using the PC/CIC value as the index, if the call reference does not already exist in this table. The process then proceeds to block **1648**, which will be described in detail below.

If, however, in block **1604** it was determined that a call reference does not exist for the endpoint name extracted in block **1602**, then, in block **1622**, a new call structure is created in memory. In block **1624**, the new call is added to the global call map (Table 7).

In block **1628** it is determined whether the message is destined for a media gateway, such as media gateway **104**. If not, then, the process proceeds to block **1642**, and the message is added to the call.

If, in block **1628** it is determined that the message is destined for a media gateway, such as media gateway **104**, then, in block **1632**, the PC/CIC that corresponds to the MGCP endpoint name, is located in table **1000** (FIG. **10**).

In block **1634**, if it does not already exist, a unique call reference is added to the table of currently established SS7 calls (Table 6) using the PC/CIC as the index value.

In block **1638**, a unique call reference is added to the table of all currently established MGCP calls (Table 8) using the MGCP endpoint name as the index value, if it does not already exist in this table. In block **1642** the message detected in block **1502** (FIG. **15**) is added to the existing call

In block **1648** it is determined whether the message is a call tear-down message having an "on-hook" property set. The "on-hook" property indicates that the call is completed. For example, in the MGCP protocol, it is determined whether the message is a DLCX or a NTFY message, having the "on hook" property set. If the message is not a call tear-down message having the "on-hook" property set, then the process proceeds to a "listen," or "wait" state **1652**. When a new message is detected, the process returns to block **1602**.

If, however, the message is a call tear-down message having the "on-hook" property set indicating the end of the call, then, in block **1654**, the calls MGCP endpoint name is removed from the table of currently established MGCP calls (Table 8). In block **1656** the call is removed from the global call map (Table 7), and, in block **1658**, the call is marked to be removed from the display (FIG. **17**).

As mentioned above, FIG. **14** describes the operation of the call display software **238** regardless of whether the message is an SS7 message or an MGCP message.

FIG. **17** is a graphical display illustrating a real-time call flow record (CFR) presented to a user of the analysis device **200**. The call flow record displays to a user all of the SS7 messages and MGCP messages that correlate to a particular call.

It will be apparent to those skilled in the art that many modifications and variations may be made to the preferred embodiments of the present invention, as set forth above, without departing substantially from the principles of the present invention. For example, the network analysis system can be used in any communication environment having at least two dissimilar communication signaling protocols. Furthermore, while illustrated using MGCP as the packet network signaling protocol, other signaling protocols, such as Internet Protocol Device Control (IPDC), Network-based Call Signaling (NCS), Transport Adapter Layer Interface

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(TALI), Signaling Transport (SIGTRAN), and Simple Gateway Control Protocol (SGCP) can be analyzed by the operation of embodiments of the invention. All such modifications and variations are intended to be included herein within the scope of the present invention, as defined in the claims that follow.

What is claimed is:

1. A method for generating a call flow record, comprising: detecting, on a first communication network, a first number of call signaling messages using a first communication protocol;

detecting, on a second communication network, a second number of call signaling messages using a second communication protocol; and

for a particular message in the first or second number of messages, the particular message being part of a particular call,

extracting a first call identifier from the particular message;

when a call reference exists for the first call identifier, adding the particular message to a call flow record for the particular call;

when the call reference does not exist for the first call identifier, i) associating the first call identifier with a unique call reference for the particular call, ii) using the first call identifier to retrieve a second call identifier for the particular call, wherein the first and second call identifiers have formats defined by different ones of the first and second communication protocols, iii) associating the second call identifier with the unique call reference, and iv) adding the particular message to the call flow record for the particular call; and

updating a call flow record display based on the addition of the particular message to the call flow record for the particular call.

2. The method of claim **1**, wherein the first communication network is a public switched telephone network (PSTN) and the second communication network is a packet network.

3. The method of claim **2**, wherein the first number of call signaling messages comprise signaling system seven integrated services digital network user part (SS7 ISUP) messages, and the second number of call signaling messages comprise media gateway control protocol (MGCP) messages.

4. The method of claim **3**, wherein:

when the particular message is one of the first number of messages, the first call identifier comprises an SS7 ISUP point code and circuit identification code (PC-CIC); and

when the particular message is one of the second number of messages, the first call identifier comprises an MGCP endpoint name.

5. The method of claim **2**, wherein the packet network is an asynchronous transfer mode (ATM) network.

6. The method of claim **2**, wherein the packet network is an internet protocol (IP) network.

7. The method of claim **1**, wherein the first call identifier is extracted by completely decoding the particular message.

8. The method of claim **1**, wherein the first call identifier is extracted by partially decoding the particular message.

9. The method of claim **1**, further comprising, performing said method in real-time.

10. The method of claim **1**, further comprising, if the particular message is a call tear-down message; removing the association between the first call identifier and the unique call reference; and

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removing the call flow record for the particular call from the call flow record display.

11. A computer readable medium storing a computer program for generating a call flow record, the computer program comprising code segments that, when executed by an instruction execution system, cause a network analysis device to perform steps comprising:

detecting, on a first communication network, a first number of call signaling messages that use a first communication protocol;

detecting, on a second communication network, a second number of call signaling messages that use a second communication protocol;

for a particular message in the first or second number of messages, the particular message being part of a particular call,

extracting a first call identifier from the particular message;

when a call reference exists for the first call identifier, adding the particular message to a call flow record for the particular call;

when the call reference does not exist for the first call identifier, i) associating the first call identifier with a unique call reference for the particular call, ii) using the first call identifier to retrieve a second call identifier for the particular call, wherein the first and second call identifiers have formats defined by different ones of the first and second communication protocols, iii) associating the second call identifier with the unique call reference, and iv) adding the particular message to the call flow record for the particular call; and

updating a call flow record display based on the addition of the particular message to the call flow record for the particular call.

12. The computer readable medium of claim 11, wherein the first communication network is a public switched telephone network (PSTN) and the second communication network is a packet network.

13. The computer readable medium of claim 12, wherein the first number of call signaling messages comprise signaling system seven integrated services digital network user part (SS7 ISUP) messages, and the second number of call signaling messages comprise media gateway control protocol (MGCP) messages.

14. The computer readable medium of claim 13, wherein: when the particular message is one of the first number of messages, the first call identifier comprises an SS7 ISUP point code and circuit identification code (PC-CIC); and

when the particular message is one of the second number of messages, the first call identifier comprises an MGCP endpoint name.

15. The computer readable medium of claim 11, further comprising, performing said method in real-time.

16. The computer readable medium of claim 11, further comprising, if the particular message is a call tear-down message:

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removing the association between the first call identifier and the unique call reference; and

removing the call flow record for the particular call from the call flow record display.

17. An analysis device, comprising:

a T1/E1 acquisition module for acquiring PSTN call signaling messages carried on a PSTN;

a packet acquisition module for acquiring packet network call signaling messages carried on a packet network;

a processor;

an input/output (I/O) controller;

a memory for storing a table that maps PSTN point code and circuit identification code (PC-CIC) identifiers to media gateway control protocol (MGCP) endpoint identifiers; and

a computer program, stored in the memory and executable by the processor, wherein execution of the computer program causes a call flow record to be generated for output via the I/O controller, and wherein execution of the computer program causes the analysis device to, for a particular message acquired via one of the T1/E1 acquisition module or the packet acquisition module, the particular message being a part of a particular call, perform the steps of,

extracting a first call identifier from the particular message;

when a call reference exists for the first call identifier, adding the particular message to a call flow record for the particular call; and

when the call reference does not exist for the first call identifier, i) associating the first call identifier with a unique call reference for the particular call, ii) using the first call identifier to index the table and retrieve a second call identifier for the particular call, wherein the first and second call identifiers respectively correspond to different ones of the PC-CIC and MGCP endpoint identifiers, iii) associating the second call identifier with the unique call reference, and iv) adding the particular message to the call flow record for the particular call.

18. The analysis device of claim 17, wherein the PSTN call signaling messages comprise signaling system seven integrated services digital network user part (SS7 ISUP) messages, and the packet network call signaling messages comprise media gateway control protocol (MGCP) messages.

19. The analysis device of claim 17, wherein the computer program further performs the steps of, if the particular message is a call tear-down message:

removing the association between the first call identifier and the unique call reference; and

removing the call flow record for the particular call from the call flow record display.

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